THE CUTTING EDGE OF SUBSISTENCE DIVERSIFICATION: USE-WEAR ANALYSIS OF A SPECIALIZED LITHIC PLANT PROCESSING TECHNOLOGY AT A MIDDLE ARCHAIC CENTRAL PLAINS SITE

By

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ABSTRACT

Archaeologists are often limited in their understanding of plant use at sites predating cultivation. Such knowledge must typically be inferred by analyses of material culture, since preservation of floral remains is generally poor for this time period. Bifacial knives from the Coffey site (14PO1) in eastern Kansas dating to the Middle Archaic Munkers Creek phase are a case in point. The knives represent a specialized plant-gathering technology predating plant cultivation on the Central Plains, which can be inferred through microscopic use-wear analysis of the tools. When compared to past studies of sickle blade use-wear and an experimental set of tools used to cut big bluestem grass, striation patterns confirm that the Munkers Creek knives are specialized plant processing implements. This is a unique feature for the Central Plains Archaic representing the onset of subsistence diversification in the region as a response to the Altithermal. The experiments which support this conclusion also indicate that plant-cutting striations may be created by abrasive materials within the plants themselves rather than by surface soil or soil adhering to the plants. Future research may identify discernable differences in these abrasive materials and the striations they create, thereby tying particular plant species to wear patterns, and potentially informing archaeologists on prehistoric plant use beyond what is currently known.

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I. INTRODUCTION

Studies of the material culture of Archaic hunter-gatherers have by necessity been focused far more on hunting than on gathering. At sites predating plant cultivation on the Central Plains, chipped stone technology informs our understanding of hunting behavior when artifacts are recovered in direct association with faunal remains. On the other hand, we are rarely able to interpret gathering behavior in the same manner, since floral remains are much less likely than faunal remains to be preserved in the archaeological record. We inevitably gain a biased perspective of Archaic hunter-gatherers as a result. Information about Archaic people's interactions with plants can potentially decrease this bias and heighten understanding of Archaic subsistence strategies, resource-gathering behavior, and technology. However, the further back in time we look, the less we know about the material culture of plant gathering due to poor preservation. Therefore our comprehension of Archaic plant processing activities and their expression in the material culture of the Central Plains is still incomplete.

Though they are few, fortunately there are some exceptions to this trend. Upon excavation of the William Young site in northeastern Kansas near Council Grove Lake, Thomas Witty (1982) posited that certain bifacial knives in the site's Middle Archaic (Munkers Creek phase) assemblage were plant processing implements due to their pronounced surface polish resembling a specific type of polish known to be associated with plant silica (Anderson 1980, Christensen et al. 1998, Kamińska-Szymczak 2002, Kamminga 1979, Unger-Hamilton 1984, Witthoft 1967). Knives of this type were also recovered from a Munkers Creek assemblage at the Coffey site, which is located in northeastern Kansas along the Big Blue River near Tuttle Creek Lake (Schmits 1978:74). This study examines the Coffey site's Munkers Creek knives in order to assess Witty's supposition that this tool type is associated with plant processing. This is accomplished by going beyond the tools' macroscopic polishes to describe and analyze their microscopic use-wear (striations).

Such a study has the potential to provide valuable information about plant processing not only at Coffey, but for the Archaic in general. Middle Archaic peoples engaged in subsistence diversification as a response to climate change (McBrinn 2010, Meltzer 1999, Wedel 1986:78), so analyzing the microwear of plant-gathering technologies can aid in understanding how these groups' increasingly diverse plant resources were gathered. Because wear patterns can indicate tool motion, it is possible to gain insight into the specific ways that Archaic peoples used plant-gathering implements, gaining a better understanding of Archaic behaviors as a result. Furthermore, if we explore how resource diversification extends beyond the use of plants for food, associations between non-food related plant use and processing behavior (informed by wear patterns) may assist in conceptualizing Archaic lifeways overall.

A microwear analysis of the tools from Coffey cannot alone provide an adequate understanding of these issues, as it provides no point of comparison. Therefore, this study uses an experimental set of grass-cutting tools as a comparative basis by which to best understand use-wear, and by extension behavior, at Coffey. The way that grass is collected, namely the height at which it is cut, carries implications for the way it is used. Activities requiring collection of the entire plant differ from those requiring only a portion of the plant. With this in consideration, the experimental tools represent different grass-collecting strategies where grass was cut at various heights. This is done with dual purpose: 1) to see if cutting grass at a particular height results in different use-wear patterns, which may potentially be used to interpret behavior at Coffey if any single pattern is seen in both the prehistoric and experimental sets of tools, and 2) to better understand how striations are formed on tools during plant cutting, by determining how cutting location (i.e. distance from abrasive soil particles) might affect the appearance of microscopic striations resulting from tool use. Overall, if striation patterns differ according to degree of soil contact (and thus, cutting location), and if a particular pattern can be matched with those potentially seen on the Coffey tools, then this study will positively impact our understanding of the gathering and use of grasses by Archaic people at the Coffey site.

II. BACKGROUND

a. The Middle Archaic

The Middle Archaic period, ranging roughly from 6,000-4,000 B.P. (Thies and Witty 1992:139), spans the Altithermal, a period of warming that brought a hot, dry climate to the Great Plains, increasing erosion and changing the landscape significantly (Antevs 1948; As a note, all dates reported here and elsewhere in the paper are in radiocarbon years BP.). The effects of the Altithermal varied across the Plains, and consequently, local adaptations of Archaic peoples living in the Plains in response to climate change were highly variable as well (McBrinn 2010, Meltzer 1999, Wedel 1986:78). For example, at the Mustang Springs site located on the High Plains of Texas, several water wells dating to about 5,000 B.P. were dug in response to Altithermal drought (Meltzer and Collins 1987). Meanwhile, there is evidence from the western margins of the Plains in Wyoming for the construction of houses during this time, signifying longer and repeated visits to particular resource-rich locales (Smith 2003). One case represents a significant need for water, while the other demonstrates environmental richness, but both occurred on the Plains during the Altithermal.

Locally variable responses to the Altithermal also extend to hunting and gathering. People adopted strategies that were better suited to a drier environment and to abandon the specialized bison-centric Paleoindian strategies of the Early Holocene. The Archaic was overall a time of subsistence diversification due to the climatic changes brought about by the Altithermal (Blackmar and Hofman 2006, Wedel 1986:72). For instance, increased evidence for earth ovens used to process roots and bulbs (Thies and Witty 1992:154-155) and groundstone milling implements (Meltzer 1999:412) suggests a greater reliance on plants for subsistence. Flotation samples from various sites have provided a glimpse at some of the plants Archaic peoples were exploiting, such as sunflower, bulrush, or marshelder (Adair 2006:252). By examining the varied occurrence of plants at different sites, we are able to gain a sense of Archaic peoples' mobility and settlement patterns, as they selected plant resources from a number of environmental zones across the landscape. The Archaic during the Altithermal is also marked by a shift away from specialized bison hunting to a more generalized small game hunting and fishing strategy, as environmental changes resulted in loss of land for bison to graze. Bison did remain a central resource, especially during the Early Archaic (Widga 2007), but their presence is generally reduced relative to Paleoindian sites (Meltzer 1999).

b. The Munkers Creek Phase

Although generalized subsistence is associated with the Archaic, specific adaptations differ somewhat across space (McBrinn 2010, Meltzer 1999). As a result, most Archaic assemblages are highly varied, making it difficult to identify specific cultural complexes by their material culture. The Munkers Creek phase of the Middle Archaic is an exception – based on its presence in three deeply buried sites – Cow Killer, Coffey, and William Young -- (Reynolds 1984, Schmits 1978, Witty 1982) and others, it is well defined on the basis of diagnostic material culture (Blackmar and Hofman 2006:74, Thies and Witty 1992:146). It was first defined by Witty (1982) in his report on the Munkers Creek type site, the William Young site. He identifies Munkers Creek sites by their distinctive projectile points, knives, gouges, and axes (Witty 1982:218). Witty defines the knives, of particular interest to this study, based on nine complete Munkers Creek (Type I) knives from William Young as follows: narrow, curved, thin, and having silicate polish on both faces (Witty 1982:150). The Munkers Creek phase can also be defined temporally. Witty's report places it during the Late Archaic,(Witty 1982:219), but corrected radiocarbon dates using updated technology indicate that it appears as early as 6,250

B.P., peaks at 5,640 B.P., and disappears by 4,850 B.P. (Banks and Wigand 2005:181). This means that while Witty initially assigned the Munkers Creek phase to the Late Archaic based on dates and composition of the artifact assemblage (Witty 1982:222), updated dating techniques and general understanding of the Archaic make the Middle Archaic a more fitting temporal distinction for this phase (Thies and Witty 1992). This places Munkers Creek at the tail end of the Altithermal. Finally, Munkers Creek sites are defined spatially. Current data indicate that the Munkers Creek phase as a whole is geographically confined to eastern Kansas, particularly the Flint Hills and Osage Cuestas regions, and its sites all occur on floodplains of major rivers and tributaries in the region (Witty 1982:218-219).

c. The Coffey Site

Among the best-documented Archaic sites is the Coffey site (14PO1). This multi-component site which yielded a Munkers Creek record is located on a floodplain in eastern Kansas (see Figure 1). The site is in Pottawatomie County, 30 miles north of Manhattan, KS (Schmits 1978:77) in an ecotone between woodlands and grasslands (Schmits 1978:74). It has been excavated multiple times over several decades, but the data in this study pertain only to the excavations of the Munkers Creek component reported by Schmits (1978). This area is now in the middle of the Big Blue River due to recent meandering and erosion (McLean 2010:3), but at the time of excavation, it was located on a floodplain along the river's east bank (Schmits 1978:77). Mean radiocarbon dates place the Munkers Creek horizons of Coffey as follows: Horizon III-5 at 5,163 B.P. (WIS-618, WIS-623), Horizon III-7 at 5,175 B.P. (WIS-624, WIS-628, WIS-634), and Horizon III-8 at 5,270 B.P. (WIS-629, WIS 636) (Schmits 1978:85). This succession of dates is consistent with site stratigraphy as well as Banks and Wigand's (2005) corrected dates for Munkers Creek.

As noted, Munkers Creek occupations are in part identified by their diagnostic artifacts, and 11 bifacial Munkers Creek knives were recovered from Coffey (see Figure 2). All are made from local Florence chert and measure about 9-15 cm in length, 4 cm in width, and 1 cm in thickness (Witty 1982 150-152). The knives from Coffey largely fit this description, and the two complete specimens in the assemblage measure roughly 12 cm long, 3.5 cm wide, and 1 cm thick. The remaining nine broken knives have the same relative thickness (and width, when applicable). All of the knives have silicate polish comparable to that of grass-cutting blades, typically known as “sickle gloss” (Bettison 1985, Kamińska-Szymczak 2002, Kamminga 1979, Keeley 1980:60, Vaughan 1985:36, Witthoft 1967). Furthermore, for all of the Munkers Creek knives from Coffey with intact bases, the bases are left unfinished with some cortex remaining. This is also consistent with the William Young knives (Witty 1982:150).

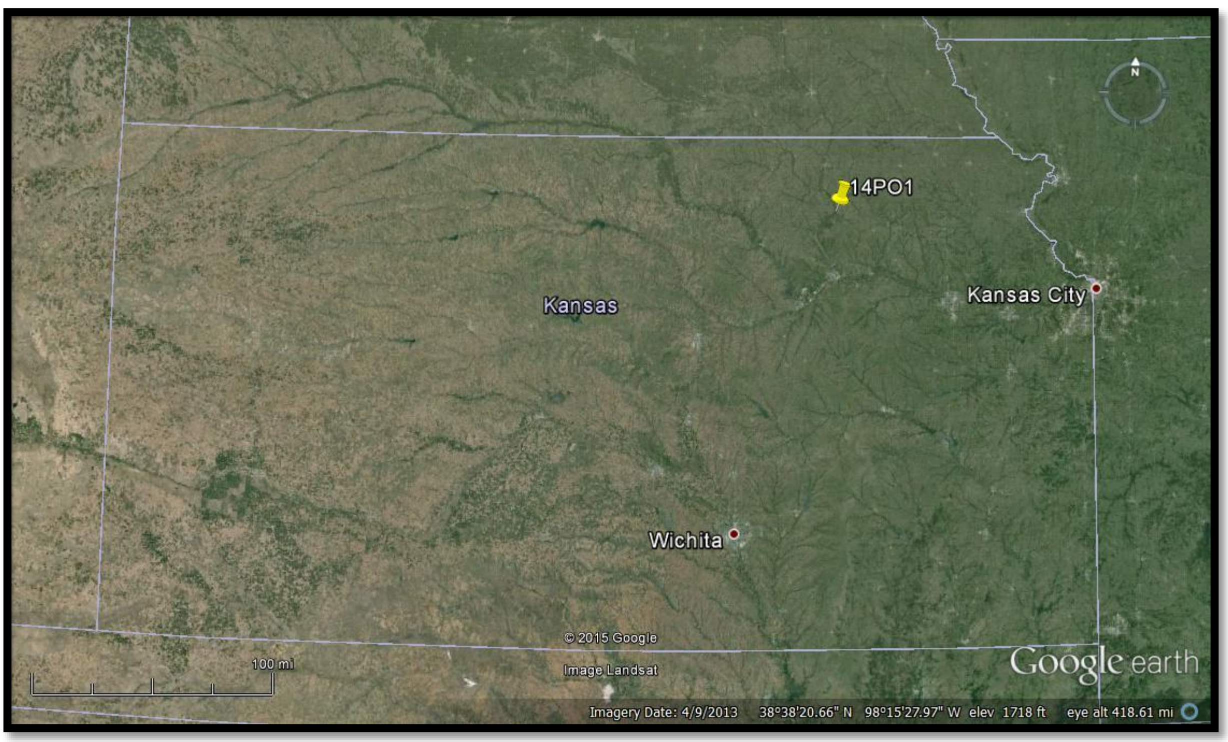

Figure 1. Map pinpointing the location of the Coffey site (14PO1) along the Big Blue River. From Google Earth, 2015.

By contrast, other bifacial artifacts termed “knives” from the Coffey assemblage are more varied in shape, size, and thickness, resulting in the isolation of Munkers Creek knives morphologically. For example, a bifacial knife from Horizon III-7 (called B2 in this analysis) is comparable in length to the complete specimens from Coffey, but it is 2-3 cm wider and up to about 0.7 cm thicker than any of the Munkers Creek knives in the assemblage. Some knife fragments, especially distal fragments, conform to the Munkers Creek morphology but do not have silicate polish. Furthermore, none of the other knives have unworked bases. Overall, the full combination of features demonstrated by Coffey’s Munkers Creek knives is not present on other bifacial implements in the assemblage. The knives are clearly unique and therefore have the potential to provide a pointed view of life at Coffey.

There are multiple lines of evidence suggesting that the inhabitants of Coffey engaged in the subsistence diversification that characterizes the Archaic. The first of these is provided by the site’s extensive faunal assemblage. The MNI for various faunal classes is 22 mammals, 16 birds and waterfowl, 172 fish, 3 amphibians, and 6 reptiles (Schmits 1978:133). Of the 22 individuals, 11 mammal species are represented with bison (likely *Bison bison*) and deer (*Odocoileus*) being more numerous than the various small mammals that make up the faunal assemblage (Schmits 1978:135). Fish were by far the most abundant resource in the assemblage with the highest MNI (Schmits 1978:141), which comes as no surprise considering Coffey’s proximity to a river. Though other faunal resources were less prevalent than fish and mammals, there is a clear indication that “the Coffey residents had a diffuse broad-based diet rather than a specialized focal adaptation to a few species” (Schmits 1978:160). Floral remains, though somewhat sparse, are also varied: for the earliest occupation (Horizon III-8), excavators recovered bulrush (*Scirpus*), grape (*Vitis*), Solomon’s seal (*Polygonatum*), and knotweed (*Polygonum*). The middle occupation (Horizon III-7) yielded goosefoot (*Chenopodium*) and bulrush. The latest (Horizon III-5) had goosefoot (*Chenopodium*), knotweed, and hackberry (*Celtis*) (Schmits 1978:164). Wood charcoal provides evidence for the presence of ash and elm as well as trees from the *Acer*, *Populus*, and *Salix* genera. Overall, the faunal and floral assemblages reveal the presence of various biotic communities around Coffey, meaning that the site's inhabitants exploited grassland, woodland, and river resources (Schmits 1978:152). This pattern of subsistence diversification at the site aligns with expectations for Archaic lifeways, and it reveals that the environment at Coffey was not as intensely affected by the Altithermal as were areas further west.

The floral and faunal assemblages of Coffey's Munkers Creek horizons also provide clues about the seasons of site occupation. Schmits (1978:158) states that Horizon III-5 (the latest) represents an early fall occupation based on presence of charred goosefoot seeds and remains of migratory waterfowl. Horizon III-7 was occupied during the late summer based on the presence and seasonal availability of Canadian goose (*Branta canadensis*) and bulrush (Schmits 1978:158). Finally, the earliest occupation, Horizon III-8, is considered a late summer occupation due to the presence of bulrush and Solomon's seal and the absence of fall resources (Schmits 1978:158-159).

Unruh (2008:50-51) contests that Horizons III-7 and III-8 represent winter occupations (both summer and winter for Horizon III-7) based on an examination of wear on bison molars recovered from these horizons. Because the seasonality of bison mating and birthing is known, site seasonality can be determined from bison remains by learning the ages of the bison when they were killed and deposited at the site. Ages can be determined according to the degree of

Figure 2. Munkers Creek knives from the Coffey Site: (a) Horizon III-5; top row, left to right: H5-5, H5-7; bottom row, left to right: H5-1, H5-2, H5-3, H5-4, H5-6 (b) Horizon III-7; left to right: H7-1, H7-2 (c) Horizon III-8; left to right: H8-1, H8-2

wear present on teeth. In sum, Unruh's (2008) interpretation contrasts with Schmits' (1978:159) suggestion that the site was abandoned before winter. Put together, Schmits' and Unruh's data suggest that Horizons III-7 and III-8 were occupied from late summer until at least early winter. It is possible that the same is true for Horizon III-5, but current evidence points to an early fall occupation only.

d. Big Bluestem

Using this information on resource exploitation and seasonality to understand Coffey as a representation of a broad-spectrum Archaic diet is imperative to reconstructing Archaic plant processing, but it is also essential to consider non-subsistence related uses of plants to gain a more complete picture of Archaic plant use. Consider grass, for example, which is largely inedible and thus not often collected for food, as it only offers its seed in the early fall. If Archaic people collected grass en masse, then we must ponder what sorts of activities required the collection of such large amounts. Conversely, if grass was only collected sporadically, then it likely served a very different purpose. Either way, seeking clarity for these possibilities in order to understand the roles of plants that were not gathered for food at Coffey is imperative to understanding human interaction with the environment during the Archaic.

In an attempt to do this, this study relies on replicating some aspects of plant-gathering activities through experimentation. Because grass is an excellent example of a floral resource often used for non-food purposes, big bluestem grass (*Andropogon gerardii*) was chosen as a proxy for interpreting information yielded by Coffey's Munkers Creek knives. Big bluestem is one of the main components of Kansas' tall grass prairie, where Coffey is located (Küchler 1974). Some of the tall grass prairie probably changed to mixed grass during the Altithermal, but it was likely still present near Coffey despite some losses, especially in the lowland floodplain areas that the people of Coffey exploited for resources (Schmits 1978:105-106).

Big bluestem was also chosen for this study because its various uses by historic Plains groups have been chronicled in the ethnographic record, providing a set of documented customs potentially associated with plant use behaviors at Coffey. One of its most notable functions for historic groups was as a building material. Gilmore (1919:68**)** reports that groups in the Missouri River region used it "to lay on the poles to support the earth covering of the lodge**s**." Plains Apaches occasionally used big bluestem as thatch material as well (Jordan 1965:142). Archaeological data reveal that big bluestem was also used as a construction material for Mississippian dwellings, as it is frequently associated with their burned remains (Powell 1980:13, Simon 2002:287). The use of grass in general, beyond just big bluestem, to cover dwellings is widely documented for historic Plains groups such as the Omaha (Dorsey 1896:269), Pawnee (Hyde 1974:173), and Wichita (Nabokov and Easton 1989:124), to name a few. The Omaha and Pawnee are also known to have used grass to line their residential storage caches (Fletcher and La Flesche 1911:98, Weltfish 1965:268).

Different types of grasses or grass-like plants like sedges were commonly used to weave mats as well (Densmore 1928:378, Gilmore 1919:69, Grinnell 1889:268, Ritzenthaler and Peterson 1956:75). The use of big bluestem for this purpose has been documented among Plains Apaches:

> For a mattress, a canvas was spread on the ground, and bunches of dried bluestem were cut with a knife and arranged on the canvas to the desired thickness. Then another canvas was placed on top of the grass, and the whole bed was secured in

> place by pegs driven into the ground. Sometimes one large canvas would be used to hold the grass stuffing. Bunches of grass were placed on one half of the canvas and then the other half was folded over them and tacked in place with heavy thread of twine [Jordan 1965:141-142].

Big bluestem also had some medicinal uses. Plains Apaches used it as a switch in their sweat lodges to cure pain and drive away evil spirits (Jordan 1965:99), and Chippewas made a decoction of its roots to treat stomach pain (Densmore 1928:342). Gilmore reports on its medicinal use among the Omaha:

> A decoction of the lower blades of this grass chopped fine was drunk in cases of general debility and languor without definitely known cause. The same decoction was used also for bathing in case of fevers, for this purpose a cut being made on the top of the head to which the decoction was applied [Gilmore 1919:69].

The preceding information highlights various plant use customs that often go undetected in reconstructions of prehistoric lifeways. Although floral remains can be preserved at archaeological sites through charring, as is the case for Coffey, they only provide a glimpse of how people of the past interacted with plants. To work towards a reconstruction of prehistoric plant use that better resembles the understanding we have gained from ethnographic literature, it is necessary to go beyond the sparse floral record and analyze the material culture that is more commonly preserved at Plains prehistoric sites. While the floral record may indicate what types of plants prehistoric people used, material culture, especially stone, can potentially allow us to understand how they were used.

e. Use-Wear of Plant Processing Implements

Chipped stone in particular has the potential to inform us about plant use via microscopic use-wear studies. Striation patterns associated with plant processing – specifically, grass-cutting – are well-defined based on use-wear analyses of stone sickle blades (Clemente and Gibaja 1998:458, Del Bene 1979:169, Keeley 1980:61, Miller 2014:296, Semenov 1964:118-119, Vaughan 1985:36). The wear has three major characteristics: 1) striations oriented parallel to the working edge of the tool, 2) comet-shaped striations, and 3) occurrence of wear on both faces of a working edge. These three characteristics indicate a cutting motion towards the tool handler, where the comet shapes are formed head-to-tail. Witty detected striations at low-power magnification on one of the Munkers Creek knives from the William Young site, and they suit the criteria for plant-processing (Witty 1982:157). The striations typically appear more oblique to the edge than parallel, but this probably has to do with the way the tool was held and did not deter Witty from understanding the striations as indicators of use of the knife to cut plants (Witty 1982:156).

Though the wear pattern for sickle blades is well documented, the exact process that creates wear on stone tools is poorly understood. The cause of the accrual of silicate polishes for example is still debated (Anderson 1980, Christensen et al. 1998, Kamińska-Szymczak 2002, Unger-Hamilton 1984), and there seems to be no definitive answer as to what creates striations. Experimental studies suggest that soil particles are the abraders that create striations on stone (Clemente and Gibaja 1998, Unger-Hamilton 1985), but in a study of threshing sledges, Anderson et al. (2006) argue that striations are created not on the stone itself, but on a sheet of phytoliths that is transferred from the straw being cut and adheres to the stone. Wear associated with grass cutting may be well-documented, but there is still much to learn about the creation of striations. This study aims to contribute to this discussion.

III. METHODS

The three Middle Archaic horizons of the Coffey site yielded a total of 11 Munkers Creek knives, which were analyzed for microscopic striations. Seven of the knives came from Horizon III-5. Horizons III-7 and III-8 each contained two knives. All 11 are made of locally available Florence chert. Only two of the knives are complete – one comes from Horizon III-5, the other from Horizon III-8. All specimens have the previously mentioned "sickle gloss." Some tools exhibit more of this polish than others, but all have it to some degree.

The 11 knives from the Coffey site are treated here as a specific tool form not just based on Schmits' (1978) classifications, but on obvious morphological differences between these tools and other bifaces termed "knives" by previous analysts. Other knives may be comparable to Munkers Creek knives in thickness, width, or length, but all three of these dimensions are not shared by other Munkers Creek knives or bifacial implements. Furthermore, the aforementioned pronounced silicate polish is unique to the Munkers Creek knives, as no comparable polish is present on any of the other bifacial knives in the assemblage. Considering that most of the Munkers Creek knives in this assemblage are fragmentary, it is all the more significant that they can be easily distinguished from the other bifaces in the collection. Generally speaking, the knives can be defined as Munkers Creek knives because they fit Witty's (1982:150) descriptions of this tool type. The difference between the oldest and youngest horizons is roughly 100 years, and based on this knife sample, it does not appear that the morphology of Munkers Creek knives changed during that time span. Regardless, two other bifacial knives (not Munkers Creek type) from the assemblage were also studied for comparison to confirm whether or not any wear the Munkers Creek knives exhibited was unique to that tool type.

Alone, examining the Munkers Creek knives from Coffey cannot reveal how they were used. The above information on the use-wear of grass cutting tools can inform the interpretation, but it may only do so in reference to a known, experimental set of knives used to cut grass that can be compared to the prehistoric set. For this purpose, five tools (representing nine different cutting edges, see Figure 3) were knapped from Florence chert to be used and studied in comparison to the Coffey tools. All edges were used, unhafted, to cut big bluestem exclusively. The tools cut the grass in a parallel motion towards the user.

The first three edges (E1, E2, E3) were used to collect big bluestem from the field. The grass was in a dry, dormant state at the time of collection. The tool edges cut the grass at ground-level, allowing for the collection of the entire plant but necessitating that each piece of grass be collected one-by-one rather than in clusters. As they were used at ground-level, these three edges had the greatest degree of soil contact compared with the others. Each of the three edges were used to cut grass for 45 minutes, which was determined through trial and error to be the amount of time it took for clear and numerous striations to develop well enough to be measured. The three resulting bundles of grass were collected and used in the remaining rounds of grass-cutting to ensure that the amount of grass being cut in the experiments remained constant. The next three edges (E4, E5, E6) were used to cut these same bundles of grass approximately one foot above the first cut. To best simulate the collection of this grass from the field, the grass was firmly held near its base (to give the sense that it was still planted in the ground) and the grass was cut in groups of 4-6 stems. These were not cut individually like the first set, since big bluestem occurs in patches of this size in the field and is most naturally collected in this manner a foot above the ground. These three edges represent less soil contact, since the tools never actually touched the ground soil but may have come into contact with any windblown soil adhering to the grass. E4 was used on the same bundle as E1, E5 as E2, and E6 as E3. Finally, the last three edges (E7, E8, E9) were used in the exact same fashion as the second set of edges, the only difference being that they represent cuts made approximately two

Figure 3. Tools knapped from Florence chert, encompassing nine cutting edges, used as experimental grass-cutting tools to compare with Munkers Creek knives from the Coffey site. Each edge, not complete tool, numbered E1-E9 from left to right.

feet above the ground (or, one foot above the previous cut). These three edges represent the least amount of soil contact, being furthest away from the ground. It is also worth noting that these last three edges represent the least strenuous gathering strategy, as cutting grass two feet above the ground resulted in much less crouching and bending than did the other cuts. E7 corresponds with E1 and E4, E8 with E2 and E5, and E9 with E3 and E6.

The 11 Munkers Creek knives, two other knives from Coffey, and nine experimental edges were analyzed under a Nikon Eclipse microscope (model LV150NL) at 50X, 100X, and 500X magnification. The experimental edges were examined both before and after use, as well as before washing away soil accrued during use, to ensure that any striations documented resulted from the experiment itself and not from inadvertent processes like transportation or cleaning. The microscope is connected to a camera integrated with the Lumenera Infinity analysis software and was used to capture multi-focus composite photographs of striations on the Munkers Creek knives. Multi-focus composite photographs were necessary because the entire photographed surface did not come into focus at the same time.To orient these photographs to the tools, the locations at which each photograph was taken were marked on images of the artifacts. After recording location and orientation, the striations at 500X magnification were quantitatively measured digitally. One photograph from each face of each tool or experimental tool edge, serving as representations of larger patterns, was chosen for measurement. This results in a total of 22 photographs. On each of these, the maximum width of and minimum spacing between striations were measured in a 100 μm diameter circle. The circle was positioned wherever striations were most abundant in the photo. These measurements serve as the chief parameters by which to compare the Coffey tools to one another and to the experimental tools. Striations that could not be clearly delineated were not measured. This is particularly important to mention for the minimum spacing measurements. If a striation was not clear enough to be measured, then it was not factored into the spacing measurements. Consequently, if the space between two measured striations was occupied by an unmeasured striation, it resulted in a misleadingly large number representing striation spacing. These large, outlying numbers were therefore omitted in calculating average minimum spacing due to the way they skewed the mean.

IV. RESULTS

a. Coffey's Munkers Creek Knives

The general dimensions of the Coffey tools are listed below in Table 1. Tools labeled "H5" come from Horizon III-5 of Coffey, and "H7" and "H8" represent their respective horizons in the same manner. For reference, the original catalog numbers corresponding with these specimen numbers can also be found in Table 1. All 11 Munkers Creek knives from Coffey exhibited the three characteristics of plant processing wear, or sickle wear, outlined above. The tools did not have this type of wear exclusively, as some portions had striations more oblique or perpendicular to the working edge, but relatively parallel plant-cutting striations were more ubiquitous and easily identified exclusively on polished surfaces. Those areas with striations more oblique than parallel matched Witty's (1982:156) description of striations on one Munkers Creek knife from the William Young site. Instances of sickle wear on the Munkers Creek knives were generally uniform in terms of striation thickness and spacing. This was true from tool to tool, and it was also true for different instances of wear on the same tool. However, there were occasions where striation patterns strayed somewhat from this general trend. Furthermore, striations were not always easily delineated for measurement despite their visibility.

The average maximum width of striations across all tools was 2.55 ± 0.37 µm, and the average minimum spacing between striations was 2.98 ± 1.17 µm. Measurements gathered from two 100 µm-diameter circles per each individual tool can be found in Table 2 below. Average maximum striation width always fell between 2 and 3 µm barring one occasion, and the widest point was usually the "comet head" of the striation. Average minimum spacing was slightly more variable. The details of this variation, as well as general descriptions of wear, are outlined below for each tool. See Figures 4-14 in the Appendix for photographs of wear and their locations on the Coffey artifacts.

Table 1. Catalog numbers, fragmentation, and maximum length, width, and thickness of Munkers Creek knives from the Coffey site. Indicates existence of technical illustrations in Schmits (1978).

Specimen	Catalog Number	Max Length (mm)	Max Width (mm)	Max Thickness (mm)	Fragment	Illustrated in Schmits (1978)?
H5-1	SW Area	123.13	36.04	11.69	Complete	Yes
H5-2	A63008-54	74.59	30.53	9.35	Distal	Yes
H5-3	A63066-18	54.26	27.58	10.86	Distal	Yes
H5-4	A25423	80.71	39.39	10.49	Proximal	Yes
H5-5	A25422-b	54.15	27.52	6.89	Distal	No
H5-6	A25422-a	59.74	40.49	10.24	Proximal	No
H5-7	A25251	37.97	34.25	9.23	Distal	No
H7-1	A61018-4	53.89	30.83	10.84	Distal	Yes
H7-2	A61046-92	60.61	32.47	12.17	Distal	Yes
H8-1	A62010-1	121.12	33.35	13.71	Complete	Yes
H8-2	A62049-4	63.01	34.38	9.82	Distal	Yes

Table 2. Number of striations and their average maximum width/average minimum spacing/standard deviations for Munkers Creek knives from the Coffey site.

Specimen	Number of Striations	Avg Maximum Width (μm)	Std Deviation for Width	Avg Minimum Spacing (μm)	Std Deviation for Spacing
H5-1	30	2.26	0.63	2.64	2.21
H5-2	31	2.32	0.62	4.41	2.56
H5-3	33	2.53	0.63	2.74	1.96
H5-4	37	2.50	0.68	2.24	1.94
H5-5	23	2.46	0.84	3.54	2.80
H5-6	33	2.68	0.52	3.29	2.46
H5-7	31	3.09	0.55	2.73	1.74
H7-1	57	1.92	0.58	1.61	1.92
H7-2	41	2.73	0.53	2.50	1.60
H8-1	39	2.48	0.40	2.47	1.44
H8-2	31	2.76	0.48	2.41	1.36

H5-1: complete specimen. This tool broke at some point in time but was glued back together before being acquired for this study. Striations in Photo 1 had an average width of 2.02 µm and average spacing of 3.02 µm. Striations in Photo 2 had an average width of 2.57 µm and average spacing of 2.27 µm. Both photos were taken on opposite faces of the same working edge of the tool. All observed locations of sickle wear had a similar appearance despite slight differences in measurement.

H5-2: broken. Striations in Photo 1 had an average width of 2.15 µm and average spacing of 3.79 µm. Striations in Photo 2 had an average width of 2.48 µm and average spacing of 4.86 µm. Striations on this tool were slightly more widely spaced than on other tools – only one other photograph shows more widely spaced striations than those of Photo 2. Both photos were taken on opposite faces of the same working edge of the tool.

H5-3: broken. Striations in Photo 1 had an average width of 2.71 µm and average spacing of 3.38 µm. Striations in Photo 2 had an average width of 2.31 µm and average spacing of 2.20 µm. Both photos were taken on opposite faces of the same working edge of the tool. The difference in average spacing between the two photos is easily distinguished visually.

H5-4: broken. Striations in Photo 1 had an average width of 2.80 µm and average spacing of 3.43 µm. Striations in Photo 2 had an average width of 2.29 µm and average spacing of 1.45 µm. Only one other photograph documents striations with a lower average spacing measurement than Photo 2. The difference in spacing between the two photos is easily distinguished visually. Sickle wear was particularly ubiquitous and simple to identify on this tool, compared to others.

H5-5: broken. Striations in Photo 1 had an average width of 2.07 µm and average spacing of 2.27 µm. Striations in Photo 2 had an average width of 3.17 µm and average spacing of 6.72 µm. Photo 2 demonstrates the greatest degree of spacing between striations of all photos. Sickle wear was less common and more difficult to find on this tool. It was often too shallow to be delineated and measured properly, especially when found on the edges of the tool. As a result, both photos come from the center of the tool, on both faces, rather than the edges. Oblique striations were noticeably common on this tool in addition to the sickle striations.

H5-6: broken. This tool fragment was broken previously, but it was glued back together before being acquired for this study. Striations in Photo 1 had an average width of 2.67 µm and average spacing of 3.47 µm. Striations in Photo 2 had an average width of 2.68 µm and average spacing of 3.20 µm. Finding measurable striations was more difficult on the face from which Photo 1 was taken than on the opposite face. Both photos were taken on opposite faces of the same working edge of the tool.

H5-7: broken. Striations in Photo 1 had an average width of 3.28 µm and average spacing of 3.20 µm. Striations in Photo 2 had an average width of 2.96 µm and average spacing of 2.41 µm. Both photos were taken on opposite faces of the same working edge of the tool. The difference in spacing between the two photos is easily distinguished visually. This tool fragment had some of the most clear and abundant striations in the assemblage despite being the smallest of all 11 artifacts.

H7-1: broken. Striations in Photo 1 had an average width of 2.48 µm and average spacing of 3.81 µm. Striations in Photo 2 had an average width of 1.66 µm and average spacing of 0.90 µm. Both photos were taken on opposite faces of the same working edge, although Photo 2 was taken slightly further away from the edge than Photo 1. The measurements of Photo 2 are the lowest for both width and spacing of the entire assemblage. The difference between this instance of wear and others, including Photo 1 of this tool, are easily distinguished visually. The wear documented by Photo 2 is anomalous, while Photo 1 represents a more common pattern for all tools in the assemblage.

H7-2: broken. Striations in Photo 1 had an average width of 2.82 µm and average spacing of 2.99 µm. Striations in Photo 2 had an average width of 2.66 µm and average spacing of 2.31 µm. Both photos were taken on opposite faces of the same working edge of the tool. Clear, measurable striations were more difficult to find on the face from which Photo 1 was taken than the opposite face. Despite this, all observed locations of sickle wear were similar in appearance.

H8-1: complete specimen. Striations in Photo 1 had an average width of 2.47 µm and average spacing of 2.56 µm. Striations in Photo 2 had an average width of 2.49 µm and average spacing of 2.35 µm. Photo 1 was taken near the edge of the tool, while Photo 2 was taken approximately 1 cm away from the same edge on the opposite face. All observed occurrences of sickle wear were similar in appearance, and measurements varied little.

H8-2: broken. Striations in Photo 1 had an average width of 2.80 µm and average spacing of 2.07 µm. Striations in Photo 2 had an average width of 2.66 µm and average spacing of 2.84 µm. Both photos were taken approximately 0.5 cm away from the same working edge on opposite faces of the tool. Sickle wear was not ubiquitous on this tool, but it was clear when found. The difference in spacing between each photo is easily distinguishable.

Finally, two non-Munkers Creek bifacial knives from Coffey were examined. Both were made from Florence chert. One came from Horizon III-5 (specimen B1) and the other from Horizon III-7 (specimen B2). Both were complete specimens with different shapes, chosen to best represent the bifacial knife assemblage at large. Neither knife had an unworked base. Also, neither had visible “sickle gloss,” although small polished areas were visible at 50X magnification or more.

B1 had a maximum length of 80.64 mm, maximum width of 49.43 mm, and maximum thickness of 7.23 mm, and it was ovate in shape. It had some cortex on base, but it was not left unworked and was instead flaked as part of the base. Striations were seldom detectable on the knife, and they were weak and not oriented parallel to the edge when found. Striations tended to occur on flake scar ridges. B2 had a max length of 117.74 mm, max width 56.16 mm, and max thickness 14.09 mm, and it was triangular in shape. Striations were extremely difficult to find, even in polished areas. When found, they tended to be on high ridges, and they were not unidirectional. Overall, these two knives were not only vastly different from Munkers Creek knives in terms of morphology, but they also did not exhibit the wear characteristics that the Munkers Creek knives did. These two knives may very well have been unused or only minimally used.

b. Experimental Edges

The general dimensions of the experimental tools, most of which had two cutting edges, are listed below in Table 3. All nine edges developed some silicate polish, but to a far lesser degree than the knives from Coffey. For a couple of these, polish was almost entirely invisible to the naked eye, but it was easily seen under at least 50X magnification. For all specimens, striations associated with plant cutting were visible and only found in polished areas. Since some edges were only lightly polished, striations were sometimes scarce, but they were indeed present and visible. They were overall not as clearly developed as those on the Coffey tools, but nonetheless they were developed enough to provide a suitable comparative basis for study. E1, E2, and E3, the edges used to cut grass at ground-level and with the most soil contact, differed significantly from the other six edges. First, they developed the most polish. Second, while they did exhibit some examples of parallel plant-cutting striations, uniformly thick (not comet-shaped) striations oriented obliquely to the cutting edge were far more numerous and did not always appear to reflect cutting motion. Rather, their orientations and locations seemed random. Lastly, these thick, oblique striations were not able to be relocated after the tools were cleaned and the soil accrued during the experiment was removed.

Table 3. Maximum length, width, and thickness of five tools comprising nine edges used in experiments cutting big bluestem.

Edges Comprised by Tool	Max Length (mm)	Max Width (mm)	Max Thickness (mm)
E1, E2	121.46	37.76	13.15
E3, E4	99.56	37.26	12.61
E5, E6	101.38	44.92	13.62
E7, E8	98.03	42.95	15.74
E9	96.14	50.36	14.61

The average maximum width of striations across all tools was 2.21 ± 0.28 µm, and the average minimum spacing between striations was 1.79 ± 0.66 µm. Measurements for the experimental tool edges, both individually and grouped by which part of the grass they were used to cut, can be found in Tables 4 and 5 below. E1, E2, and E3 comprise Group 1, E4, E5, and E6 are Group 2, and E7, E8, and E9 are Group 3. Although the uniformly wide striations exhibited by Group 1 appear to be the widest of the three groups in photographs, measurements show them to actually have similar widths as the edges in the other groups. Striations from Groups 2 and 3 were more comet-shaped, and the “heads” of the comets usually were their widest points, resulting in comparable maximum width measurements for the striations despite their overall thinner appearance. The average widths for almost all tool edges fell between 2 and 3 µm, just as with the Coffey assemblage.

Minimum average spacing, however, differed from Coffey's – the striations in all three groups were closer together in comparison. Whereas Coffey's maximum average spacing never fell below 2 μm and were sometimes bigger than 4 μm, the experimental set turned up measurements primarily in the 1-2 μm range. This is a miniscule difference to the naked eye, making it difficult to detect when comparing microphotographs, but the difference is indeed present. Group 1 had two spacing measurements outside of this range, producing the most variation in one group for this measurement. Details of both maximum average width and minimum average spacing, as well as general descriptions of wear, are outlined below for each experimental edge. See Figures 15-23 in the Appendix for photographs of wear and their locations on the edges.

Table 4. Average maximum width, average minimum spacing, standard deviations, and count of microscopic striations on individual experimental tool edges used for cutting big bluestem.

Specimen	Number of Striations	Average Max Width (μm)	Std. Deviation for Width	Average Min Spacing (μm)	Std. Deviation for Spacing
E1	29	1.90	0.43	3.10	2.51
E2	34	1.95	0.62	1.64	1.18
E3	46	2.37	0.65	2.11	2.10
E4	47	2.20	0.51	1.72	1.14
E5	29	2.04	0.49	0.90	0.35
E6	49	2.09	0.37	1.44	1.10
E7	49	2.39	0.40	1.77	1.06
E8	44	2.17	0.52	1.48	0.80
E9	26	2.52	0.54	2.00	1.01

Table 5. Average maximum width and minimum spacing of microscopic striations for groups of experimental tool edges used for cutting big bluestem.

Group	Average Max Width (μm)	Average Min Spacing (μm)
1 (E1, E2, E3)	2.11	2.28
2 (E4, E5, E6)	2.12	1.43
3 (E7, E8, E9)	2.34	1.69

E1: Group 1. This edge, along with E2 (the opposite edge of the same tool), exhibited the greatest degree of polish among all edges (but was not as heavily polished as the Coffey tools). Striations in Photo 1 had an average width of 1.83 μm and an average spacing of 3.24 μm. Striations in Photo 2 had an average width of 2.02 μm and an average spacing of 2.96 μm. Both photos were taken about 1 cm away from the cutting edge near the distal end of the tool where wear was heaviest, on opposite faces. Both photos showed striations oriented obliquely to the edge, especially Photo 1, which showed striations nearly perpendicular to the edge. These two photos produced two of the largest average spacing measurements of the entire experimental edge photo set.

E2: As noted above, this edge was one of the most heavily polished. Striations in Photo 1 had an average width of 2.10 μm and an average spacing of 1.66 μm. Striations in Photo 2 had an average width of 1.74 μm and an average spacing of 1.62 μm. Photo 1 was taken about 0.5 cm away from the edge, while Photo 2 was taken about 1 cm away from the edge, and both were taken near the distal end of the tool where wear was heaviest, on opposite faces. Like E1, these striations were oriented obliquely to the edge.

E3: This edge exhibited a light polish more easily seen under magnification than to the naked eye, and it was the most heavily soiled during use of all Group 1 edges. Striations in Photo 1 had an average width of 2.70 μm and an average spacing of 2.96 μm. Striations in Photo 2 had an average width of 2.14 μm and an average spacing of 1.25 μm. Both photos were taken on the cutting edge on opposing faces. Like E1, this edge produced one of the largest average spacing measurements of the entire set, matching the number for Photo 2 of E1. As with E1 and E2, the striations in these photos were oriented obliquely to the edge and appeared quite thick despite comparable width measurements to other edges.

E4: The polish this edge accrued was light and not well-developed, but it was easily seen under magnification. Striations in Photo 1 had an average width of 2.00 µm and an average spacing of 1.71 µm. Striations in Photo 2 had an average width of 2.57 µm and an average spacing of 1.73 µm. Both photos were taken about 0.5 cm away from the edge, on opposing faces. Striations in these photos were oriented basically parallel to the edge.

E5: Polish on this edge was light and easily detectable to the naked eye, but more abundant on one face than the other. Striations in Photo 1 had an average width of 2.29 µm and an average spacing of 1.03 µm. Striations in Photo 2 had an average width of 1.88 µm and an average spacing of 0.77 µm. Both photos were taken < 0.5 cm away from the edge, on opposite faces. Both showed striations oriented basically parallel to the edge.

E6: This edge developed light polish which was only easily visible to the naked eye in a couple of spots, though easily seen under magnification. Striations in Photo 1 had an average width of 2.06 µm and an average spacing of 1.90 µm. Striations in Photo 2 had an average width of 2.12 µm and an average spacing of 0.97 µm. Both photos were taken on the cutting edge on opposite faces. Striations in these photos were oriented parallel to the edge.

E7: This edge exhibited very little polish, nearly all of which could only be seen under magnification. Striations in Photo 1 had an average width of 2.57 µm and an average spacing of 1.79 µm. Striations in Photo 2 had an average width of 2.27 µm and an average spacing of 1.75 µm. Both photos were taken on the cutting edge on opposite faces, and striations were oriented parallel to the edge.

E8: Polish on this edge was very scarce and only detectable under magnification. Striations in Photo 1 had an average width of 2.22 µm and an average spacing of 1.59 µm. Striations in Photo 2 had an average width of 2.13 µm and an average spacing of 1.37 µm. This edge was anomalous in that no striations could be detected on one of its faces, even in the few polished areas. Thus, both photos for this edge came from the same face. Both were taken at the edge, < 1 cm away from each other, in one of the only polished areas on the whole tool edge. Striations were oriented parallel to the edge.

E9: This edge developed a light polish, only a little of which was visible to the naked eye. Striations in Photo 1 had an average width of 2.44 μm and an average spacing of 1.72 μm. Striations in Photo 2 had an average width of 2.67 μm and an average width of 2.27 μm. Both photos were taken at the edge on opposite faces, and both exhibited striations parallel to the edge.

V. INTERPRETATIONS

When compared to literature on use-wear and the experimental cutting edges described in the preceding section, the striation patterns of the Munkers Creek knives from the Coffey site strongly suggest that these prehistoric tools were indeed used as plant processing implements. All of the characteristics of sickle wear outlined above are ubiquitously present in Coffey's Archaic knives. This fact is supported by the presence of comparable wear on the experimental edges, particularly Groups 2 and 3. Wear on the experimental tools was not nearly as well-developed as wear on the Coffey tools, but the lack of developed wear may simply be attributed to the experimental edges receiving less use than the prehistoric knives from Coffey. Regardless, the wear present on the experimental edges was enough to provide a suitable comparative sample, and it showed striking similarities to the wear on the tools from Coffey.

Consistencies in quantitative measurements for the striations further support the interpretations brought forth by their sickle-wear characteristics. Average maximum striation width in particular is extremely similar across all specimens within both the prehistoric and experimental groups. Mean width averages are actually statistically significant between the two groups as demonstrated by a two sample t-test ($t(38) = 3.22$, $p < 0.05$), showing that the Coffey tools had slightly wider striations, but this does not negate the fact that the similarities in numerical averages within each set of tools shows a great degree of consistency.

Average minimum spacing is more variable both within and between sets. Within the prehistoric set from Coffey, numerical averages differ no more than approximately 3 µm from one another. Within Groups 2 and 3 of the experimental set, both numerical averages and their standard deviations differ only about 1 µm from each other, and their mean spacing averages are not statistically significant ($t(10) = 1.72$, $p > 0.05$). However, there is a distinct difference in minimum average spacing measurements between the prehistoric and experimental sets despite the consistencies within them. Average spacing for the Coffey tools ranged roughly from 2-4 µm while spacing for the experimental edges in Groups 2 and 3 fell almost entirely between 1-2 µm. This is a statistically significant difference ($t(38) = 3.22$, $p < 0.05$). There is a clear pattern that striations are overall closer together in the experimental set than they are in the Coffey set. It is unclear why this is, but a variety of factors may be involved. For example, there is a distinct likelihood that the tools from Coffey were not used to cut down one single type of grass as was the case for the experimental tool edges. This probable difference must be considered when assessing the variation between the two sets of tools. On the whole, because of the minor discrepancies in wear between the experimental implements and those from Coffey, it cannot be said that the two sets were used in precisely the same manner. Nevertheless, because of the degree of consistency displayed by maximum width and minimum spacing averages, there is no doubt that the quantitative data gathered from experimental Groups 2 and 3 support the conclusion that the Munkers Creek knives from Coffey were used by Archaic peoples to gather plants, probably grasses.

Conversely, quantitative data from experimental Group 1 is anomalous. Width averages differ significantly from the Coffey tools ($t(26) = 2.74$, $p < 0.05$), but there is no significant difference in average width between Group 1 and Groups 2 and 3 ($t(10) = 0.38$, $p > 0.05$; $t(10) = 1.81$, $p > 0.05$). Average spacing is significantly different between Group 1 and Group 2 ($t(10) = 2.30$, $p < 0.05$) but not significantly different between it and Group 3 ($t(10) = 1.43$, $p > 0.05$) or the Coffey tools ($t(26) = 1.33$, $p > 0.05$). There is no clear pattern in the relationship between the Group 1 striations and those of the other experimental groups or the prehistoric group. Though lack of statistical significance in some areas does not appear to support the idea that Group 1 striations are overall very different from any others, in this case quantitative measurements are misleading considering numerous, distinctive qualitative differences between the wear in Group 1 and the rest of the tools. Firstly, the orientations of the majority of Group 1 striations were random and thus did not reflect the cutting motion used in the experiments. Some parallel-oriented striations probably associated with this activity were indeed discovered on the Group 1 tool edges and looked like those found on the rest of the experimental edges, but they did not occur as frequently as the others, which is why they were not photographed and measured as a representative example of larger patterns on the Group 1 edges. Secondly, the randomly-oriented striations on this group's edges were not comet-shaped, as plant-cutting striations should be. Rather, they were uniform in thickness. Lastly, these striations were not able to be relocated after the tool edges were washed. Only the thinner parallel-oriented striations comparable to the wear recorded on the rest of the experimental edges remained after washing. In sum, the striations photographed, measured, and presented in this paper for experimental Group 1 were superficial and only etched into the heavily soiled surfaces of the tool edges. Once this soil was washed away, the striations disappeared. Because of this, and because no such striations were present on the Group 2 and 3 edges which did not cut the grass at soil-level, we can conclude that striations produced by plant-cutting are entirely different from striations created by soil contact. If a tool makes direct contact with the ground while cutting, parallel plant-cutting striations indicating motion will form, but uniformly thick and randomly-oriented striations will also develop in the soil that accrues on the tool.

Because these vastly different striations form simultaneously, two different abrasive materials must be present and affect the use-wear in different ways. Plant-cutting striations must be etched into polished areas by abrasive materials in the plant itself (perhaps phytoliths, see

Anderson et al. 2006), while soil contacted during the cutting process accrues on the tool then abrades the same soiled surface. When the tool is washed, the soil-created wear disappears. Therefore, any plant-cutting wear found on washed prehistoric implements, such as Coffey's Munkers Creek knives, are created solely by abrasive materials in the plants they cut. A study determining precisely what these abrasive materials are and how they may differ between different plant species may be a promising avenue of future research, as such information could potentially allow archaeologists to interpret site behavior by identifying floral resources used by prehistoric groups.

This study, however, cannot provide such information. With the exception of Group 1, the use-wear on all prehistoric and experimental specimens is so similar that no conclusions may be made regarding how the inhabitants of Coffey collected grass or other plants. Even the plant-cutting striations found in Group 1, though not measured and presented here, were so similar in appearance to those in the other groups that the measurements could not have varied from Groups 2 and 3 more than those in Groups 2 and 3 varied from one another. Differences in plant-cutting striations therefore did not arise in accordance with cutting location. Because of this, we cannot narrow our guesses about how grass was used by the inhabitants of Coffey.

VI. DISCUSSION

Although this study yields no interpretations for how and why grass or other plants were used at Coffey, it does confirm the presence of a specialized plant-gathering technology on the Central Plains during the Archaic. It allows us to better understand hunter-gatherer behavior at a time and place that required people to adapt to a changing environment by modifying their strategies. We can best comprehend the role and uniqueness of Munkers Creek knives as part of a larger system of Archaic adaptations by first establishing the commonalities between other Munkers Creek sites and Coffey, then comparing the Munkers Creek phase as a whole to other Archaic complexes.

The two sites besides Coffey that have well-defined Munkers Creek occupations are William Young (Witty 1982) and Cow Killer (Reynolds 1984). The William Young site is the Munkers Creek phase type-site located on the floodplain of Munkers Creek itself, an arm of the Council Grove lake area (Witty 1982:767). Like Coffey, it represents a seasonal hunter-gatherer occupation (Witty 1982:201). Excavations of the Munkers Creek cultural zone revealed an abundance of chipped stone implements, including Munkers Creek knives (Witty 1982:170). Multiple intact features were also uncovered including 19 hearths, six pits, four post molds (isolated from one another), and multiple debitage and charcoal concentrations. There is no evidence of habitation structures besides the isolated post molds, but the number of hearths and pits present certainly suggest at least a semi-permanent occupation of the site (Witty 1982:190). The site's faunal assemblage is highly varied and indicates resource exploitation from prairie, woodland, and riverine environments. It includes deer (*Odocoieleus*) and pronghorn (*Antilocapra*) as well as many smaller mammals, but bison are noticeably absent (Witty

1982:192). Clearly, the environment, topographic setting, and resource diversity at William Young are very similar to those of Coffey.

The Cow Killer site, reported by Reynolds (1984), does not deviate from the patterns established by Coffey and William Young for the Munkers Creek phase. It too is located near water – in this case, an old terrace of the Marais des Cygnes River in the Melvern Lake area (Reynolds 1984:1). This site yielded abundant lithic debitage and a few formal artifacts, including two Munkers Creek knives and other Munkers Creek diagnostic stone artifacts. Features, like post molds, hearths, and trash middens attest to the use of the site as a seasonal camp probably similar to Coffey and William Young. The faunal assemblage at Cow killer, as with these other two sites, is varied. It includes bison in addition to deer (*Odocoieleus*), beaver (*Castor*), fish and turtle (genera unspecified), though notably, no shellfish (Reynolds 1984:76). Still, the faunal assemblage represents resource exploitation of multiple ecological zones.

Coffey, William Young, and Cow Killer all represent seasonal camps along rivers or major tributaries. In addition, all are in ecotonal settings in eastern Kansas, all have evidence for semi-permanent settlement, and all contain Munkers Creek knives among other artifacts. This indicates that Archaic subsistence diversification associated with climatic change is not only visible at Coffey, but it may very well be represented by the Munkers Creek phase as a whole. However, to best understand Munkers Creek and its specialized knives as a unique adaptation to Middle Holocene environments on the Great Plains, one must examine it within the greater context of Archaic complexes in eastern Kansas. Specifically, we may look at the traditions that temporally bracket the Munkers Creek phase – the preceding Logan Creek complex and succeeding El Dorado phase.

The Early Archaic Logan Creek complex dates to about 8,600-6,000 B.P. (Kay 1998:177), so its end coincides with the onset of the Middle Archaic and the appearance of the Munkers Creek phase. Logan Creek sites include seasonal camps, bison kills, and human burial sites (Kay 1998:176). Early Archaic sites are often thought of as representing a "'Small Game Hunting Tradition' developed in response to environmental stress and the apparent unavailability of larger animals" that were more abundant in the preceding Paleoindian period (Thies and Witty 1992:144). Sites in the Logan Creek complex indeed demonstrate reliance on small animals and riverine resources like fish and mussels, but the "Small Game Hunting Tradition" moniker may be misleading, as Logan Creek sites (especially Spring Creek in Nebraska) still represent a heavy dependence on bison in relation to later complexes (Wedel 1986:75, Widga 2007). Thus, the Logan Creek complex represents a bison-reliant adaptation to the climate change brought on by the onset of the Altithermal. This differs significantly from the subsistence diversification that developed later on during the Munkers Creek phase, so it is not surprising that no specialized plant-gathering implements like Munkers Creek knives are associated with the Logan Creek complex.

The El Dorado phase follows Munkers Creek and resembles it more closely, but it is still distinctive. It appears at the beginning of the Late Archaic, and its sites generally date after the Altithermal (Thies and Witty 1992:151). Sites of this phase, such as the Williamson site located along a tributary of the Neosho River in eastern Kansas, are often seasonal residential camps with associated mortuary areas (Kay 1998:181, Schmits 1987:171). They are best thought of as base camps representing a logistical mobility pattern (Binford 1980). Furthermore, El Dorado sites exemplify a broad-spectrum subsistence adaptation based on the variety of resources represented by their faunal assemblages as well as material evidence for plant processing, like grinding stones (Grosser 1973:233, Schmits 1987:170, Thies and Witty 1992:151). Based on this information, the El Dorado phase may be thought of as an intensification of strategies established by inhabitants of Munkers Creek sites.

It is clear that the Munkers Creek phase represents a transitional point between bison-centric adaptations and more generalized ones. Through the entirety of the Archaic, there is a gradual increase in subsistence diversification over time. Logan Creek sites represent initial adaptations to the drought brought on by the Altithermal, as they provide evidence of brief movements to ecotonal areas where multiple resource bases could be exploited, yet the heavy reliance on bison often associated with the Paleoindian period is still manifested. Munkers Creek sites like Coffey demonstrate a decreased reliance on bison (though it did remain an important resource) and clear seasonal exploitation of ecotonal, alluvial settings. A slight increase in sedentism and subsequent development of specialized technologies for resource collecting (like Munkers Creek knives) coincides with this change. Finally, El Dorado sites represent an even greater degree of subsistence diversification in settings similar to those occupied by Munkers Creek peoples and an intensification of the practices these people established.

By understanding Archaic subsistence adaptations on the Central Plains, and by confirming the existence of some of the oldest specialized plant collecting technologies in the region, the Munkers Creek phase can be understood as a period of time when the foundations of broad-spectrum subsistence, logistical mobility, and technological specialization more markedly manifested in the Late Archaic and onward were established. Its Munkers Creek knives can now unquestionably be considered material indicators of this process.

As previously mentioned, the use of plants for food is not all we should consider in a discussion of resource diversification. Instead, non-food uses like those outlined in preceding sections should be considered for Coffey. Even if the experimental results in this paper cannot definitively point to a particular type of collection behavior at Coffey, there is evidence that the Munkers Creek knives at the site were intensively used for a particular purpose. Given the fact that their use-wear is far more developed than that of the experimental tool edges, and considering the degree of consistency of average maximum striation width and minimum striation spacing among all 11 specimens, there is a strong indication that Coffey's Munkers Creek knives were not simply specialized plant-collecting implements. Rather, they may be thought of as hyper-specialized tools used on large quantities of the same type of plant. Future experimental studies may focus on precisely which plant this may be while considering this paper's suggestion that the plant in question was needed in large amounts. We may look to ethnographic data such as that discussed above to inform our ideas of what activities are represented by Munkers Creek knives. For example, if we look to the use of grass as a building material, we understand that a very large amount of grass would have needed to be collected in a short amount of time in order to construct a grass house. This type of collection behavior is supported by the microwear exhibited by the Munkers Creek knives from Coffey, and it is one suggestion of how we may begin to understand the activities of Coffey's inhabitants.

It is interesting, however, that no hyper-specialized plant-collecting implements are currently known for the Late Archaic in the Central Plains. While Munkers Creek knives are indeed physical indicators of the adaptations that were established during the Altithermal and continued into the Late Archaic, the knives themselves do not have any Late Archaic successors. We must ask why this is the case. Was this hyper-specialized technology unsuccessful? Was there no longer a need for the activities that necessitated the Munkers Creek knives? Were the same activities carried out with a different implement? If so, does preservation bias account for our lack of knowledge of such an implement – for example, if the tool were made of bone, which does not preserve as well as stone? Future research into these questions may prove beneficial for our comprehension of Central Plains Middle Archaic adaptations and behaviors.

VII. CONCLUSION

This study supports the existence of a hyper-specialized plant-gathering technology at a Middle Archaic Munkers Creek site in eastern Kansas. Since other Munkers Creek sites have yielded these same Munkers Creek knives, but sites predating and postdating the Munkers Creek phase have not, this technological specialization is unique to the Middle Archaic for the Central Plains. Munkers Creek knives were already considered temporal markers for sites in the region, but now it is certain that they also designate the beginning of subsistence diversification in response to the Central Plains Altithermal. Munkers Creek knives represent a marked increase in reliance on plants within the Middle Archaic hunter-gatherer economy, a subject about which so little is known. This may not necessarily pertain to the use of plants as food, but instead to non-food-related activities such as dwelling construction. Although ethnographic data yields strong suggestions, no interpretations can yet be definitively made regarding how plants were used by the Coffey site's inhabitants nor Munkers Creek peoples as a whole, as this study concludes that the manner in which plants are gathered makes no discernable difference in lithic use-wear. However, it does confirm that plants themselves, rather than soil at the base of or adhering to the plant, create an unmistakable and distinctive wear pattern on lithic implements. Because of this, we should explore the possibility that different plants produce different wear patterns. So, while this study can only emphasize resource diversification during the Middle Archaic rather than reconstruct prehistoric plant-gathering behavior and plant use, the information presented here regarding the creation of use-wear through plant gathering has the potential to reveal specific details about the collection and use of plants if abrasive particles in plants are proven in future research to differ according to species.

VIII. APPENDIX

Photographs of microwear at 500X magnification and their locations on Munkers Creek knives from Coffey and experimental tool edges

Figures 4-23

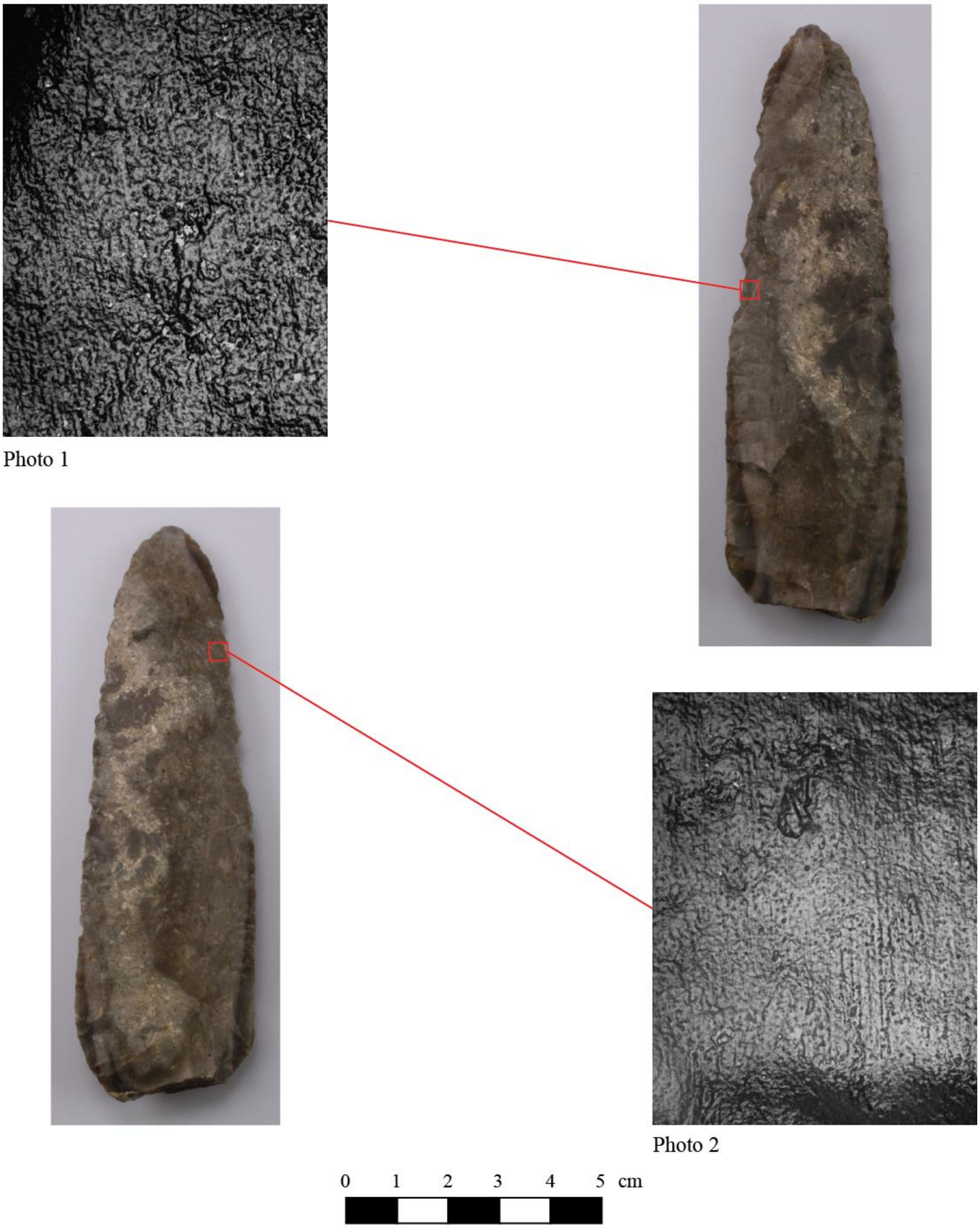

Figure 4. Locations of wear at 500X magnification on tool H5-1 from the Coffey site.

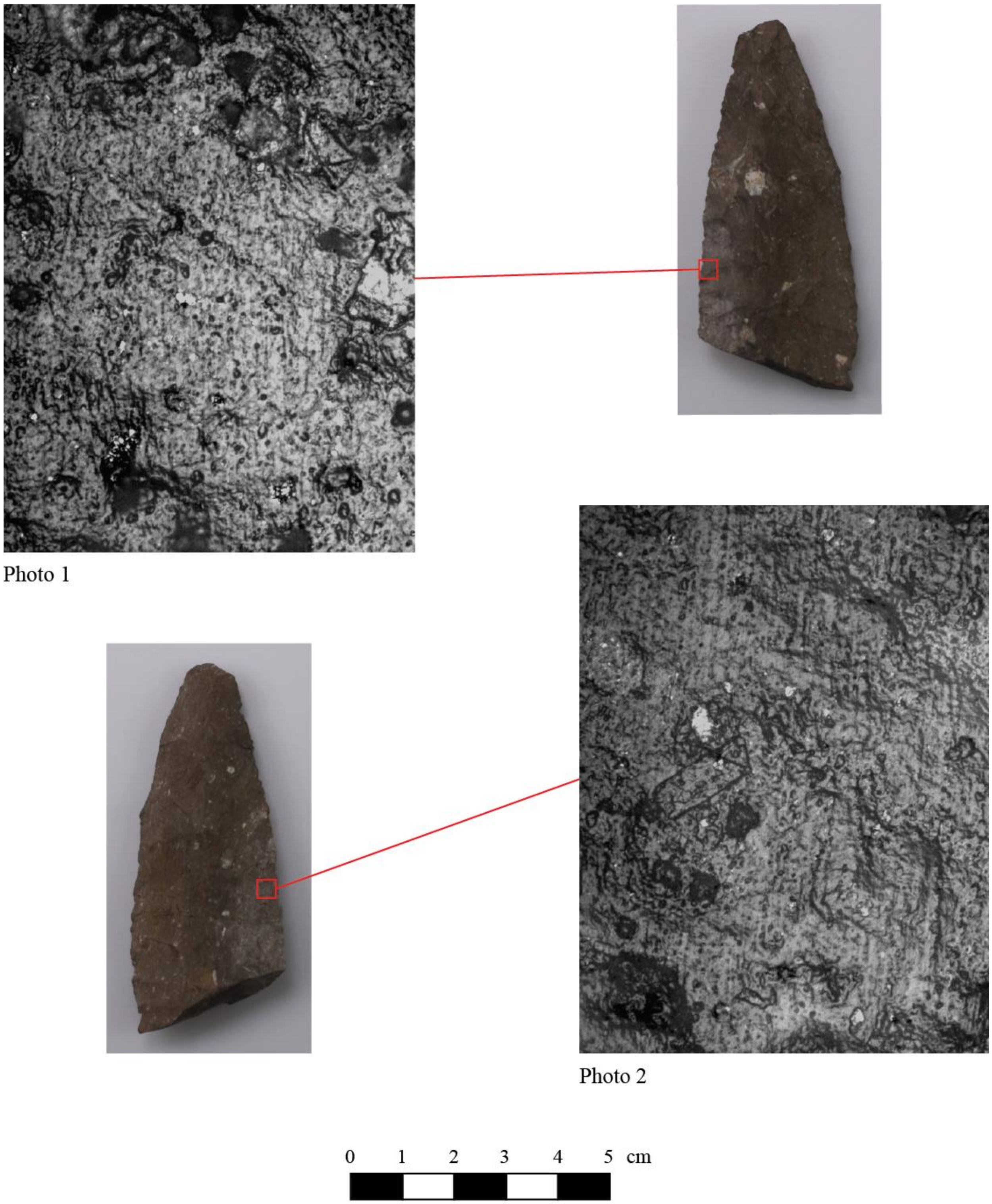

Figure 5. Locations of wear at 500X magnification on tool H5-2 from the Coffey site.

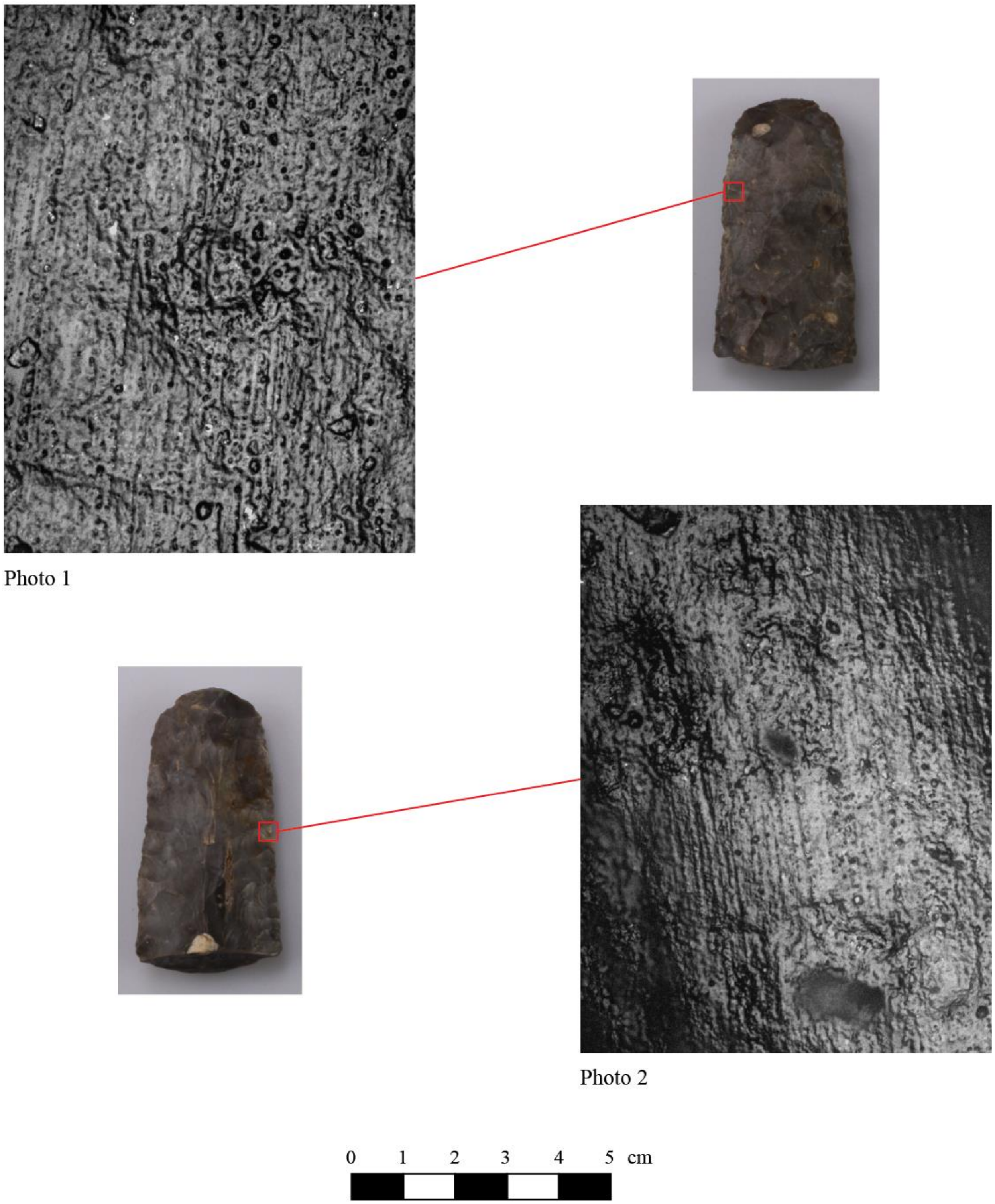

Figure 6. Locations of wear at 500X magnification on tool H5-3 from the Coffey site.

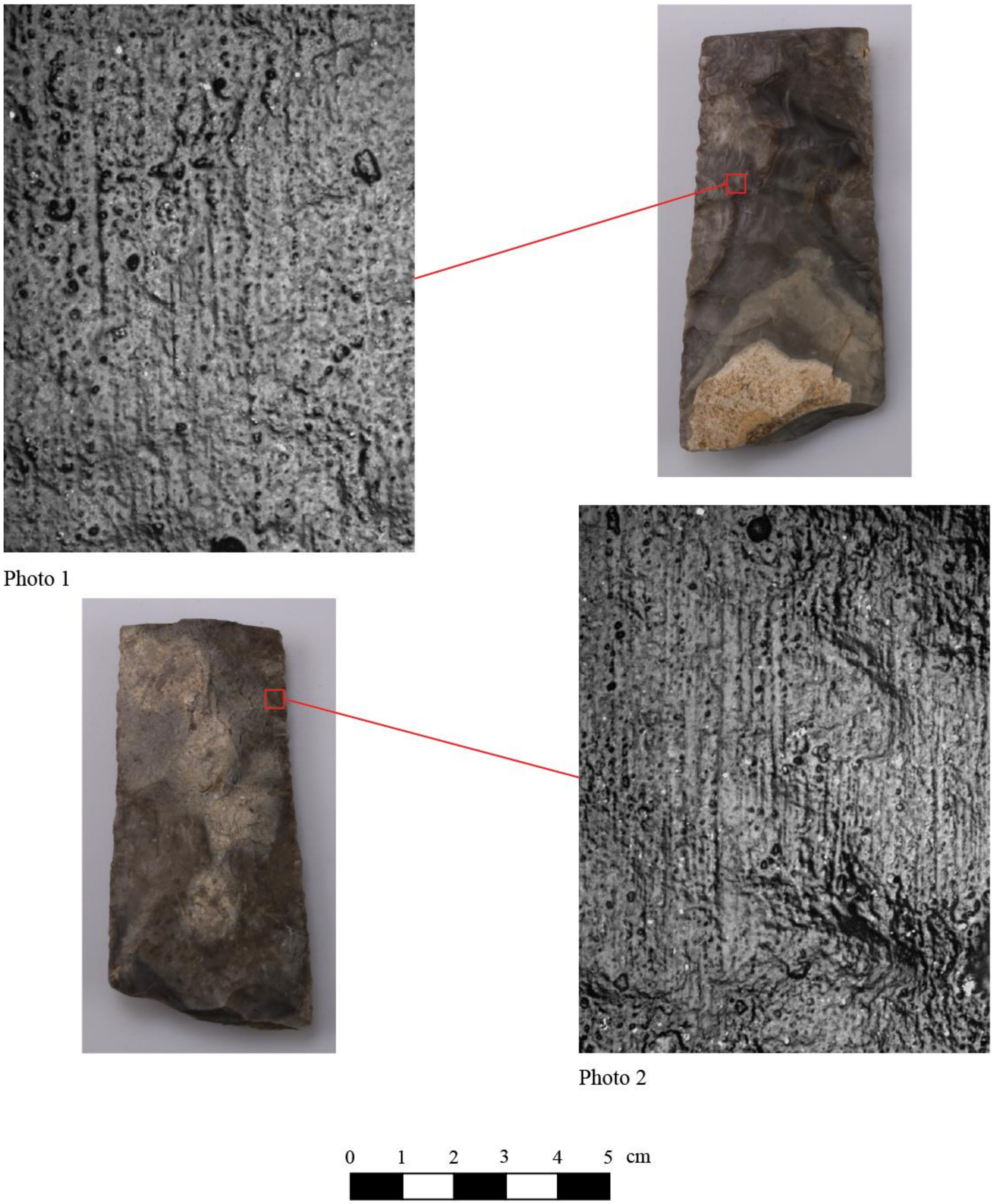

Figure 7. Locations of wear at 500X magnification on tool H5-4 from the Coffey site.

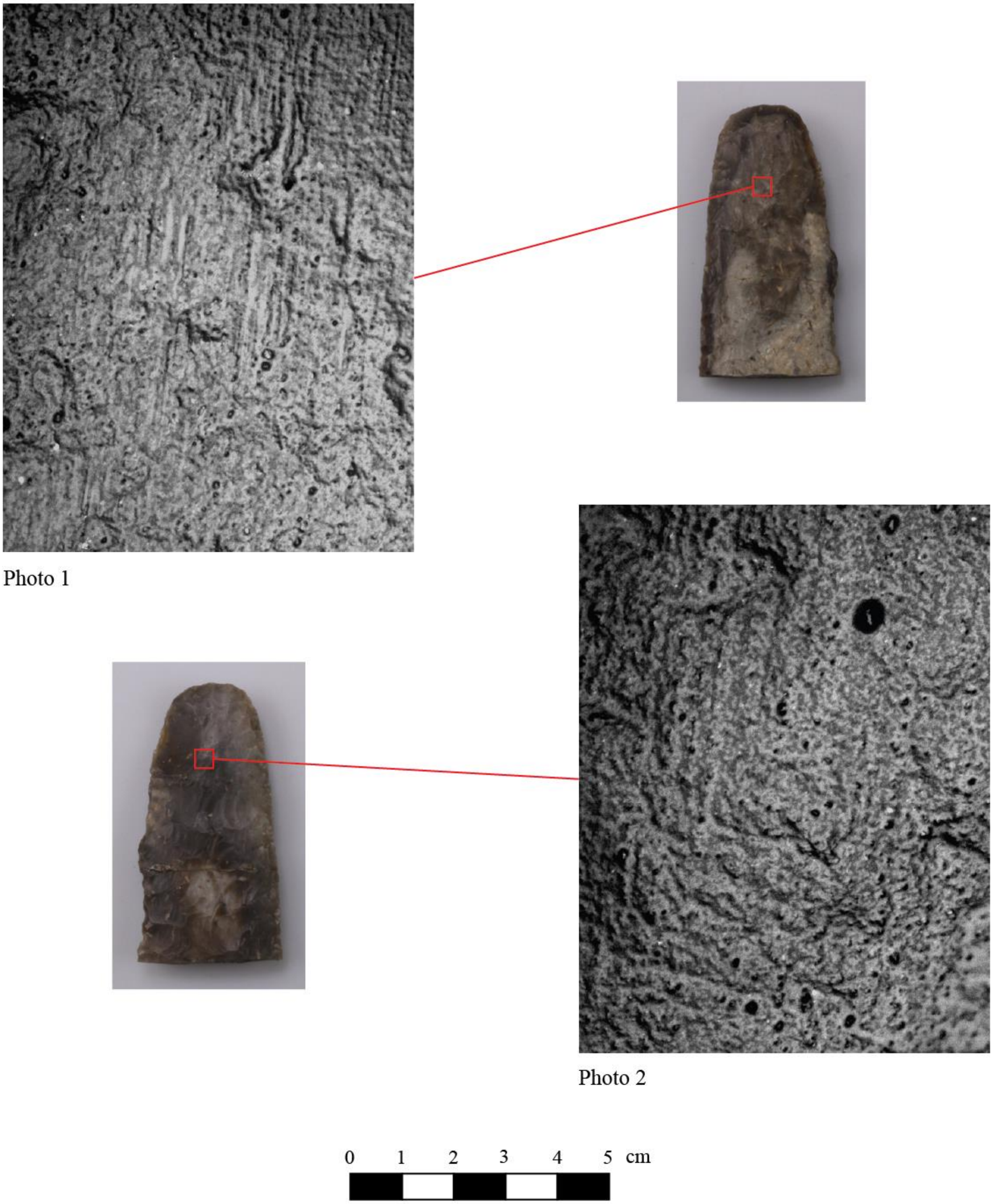

Figure 8. Locations of wear at 500X magnification on tool H5-5 from the Coffey site.

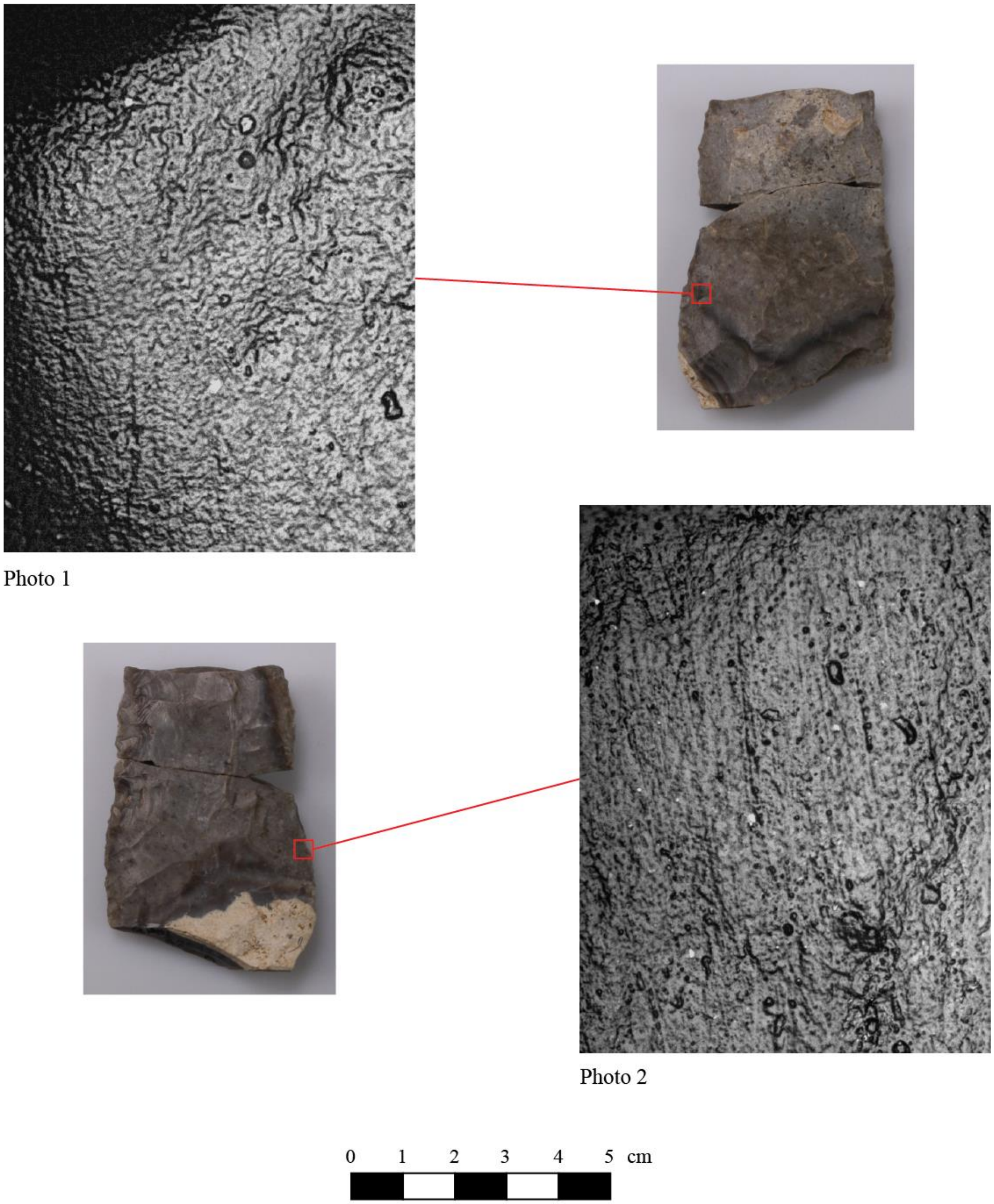

Figure 9. Locations of wear at 500X magnification on tool H5-6 from the Coffey site.

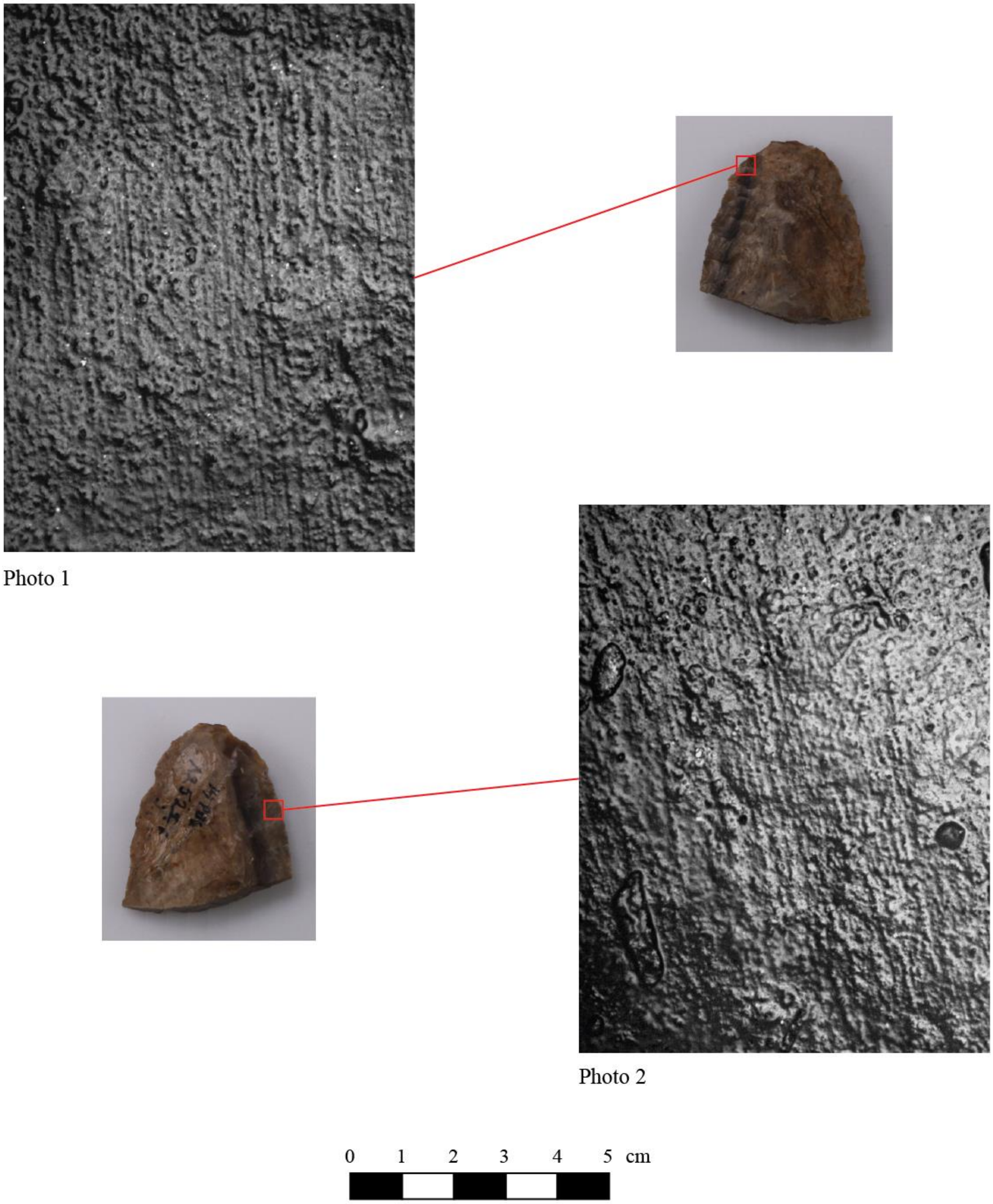

Figure 10. Locations of wear at 500X magnification on tool H5-7 from the Coffey site.

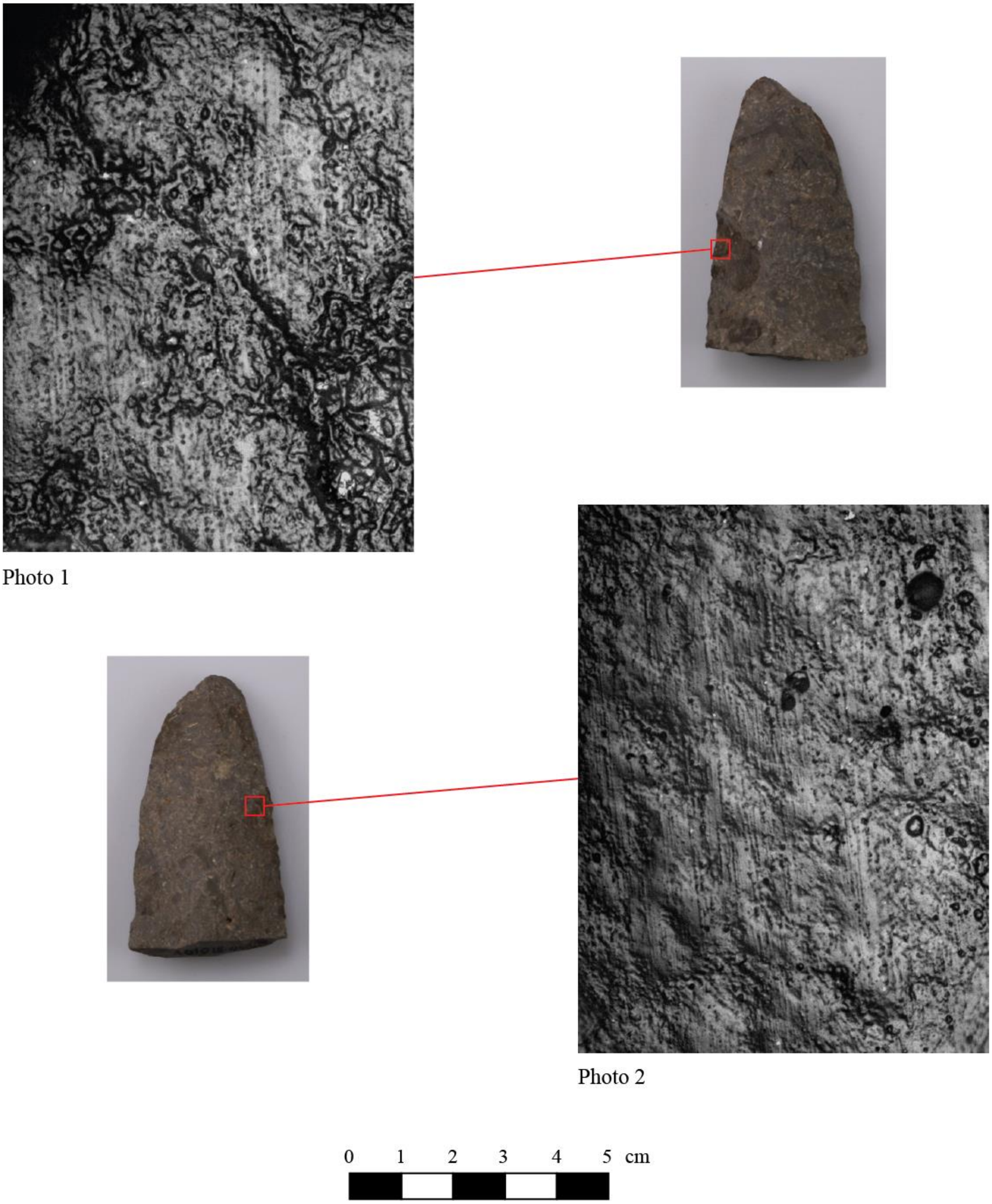

Figure 11. Locations of wear at 500X magnification on tool H7-1 from the Coffey site.

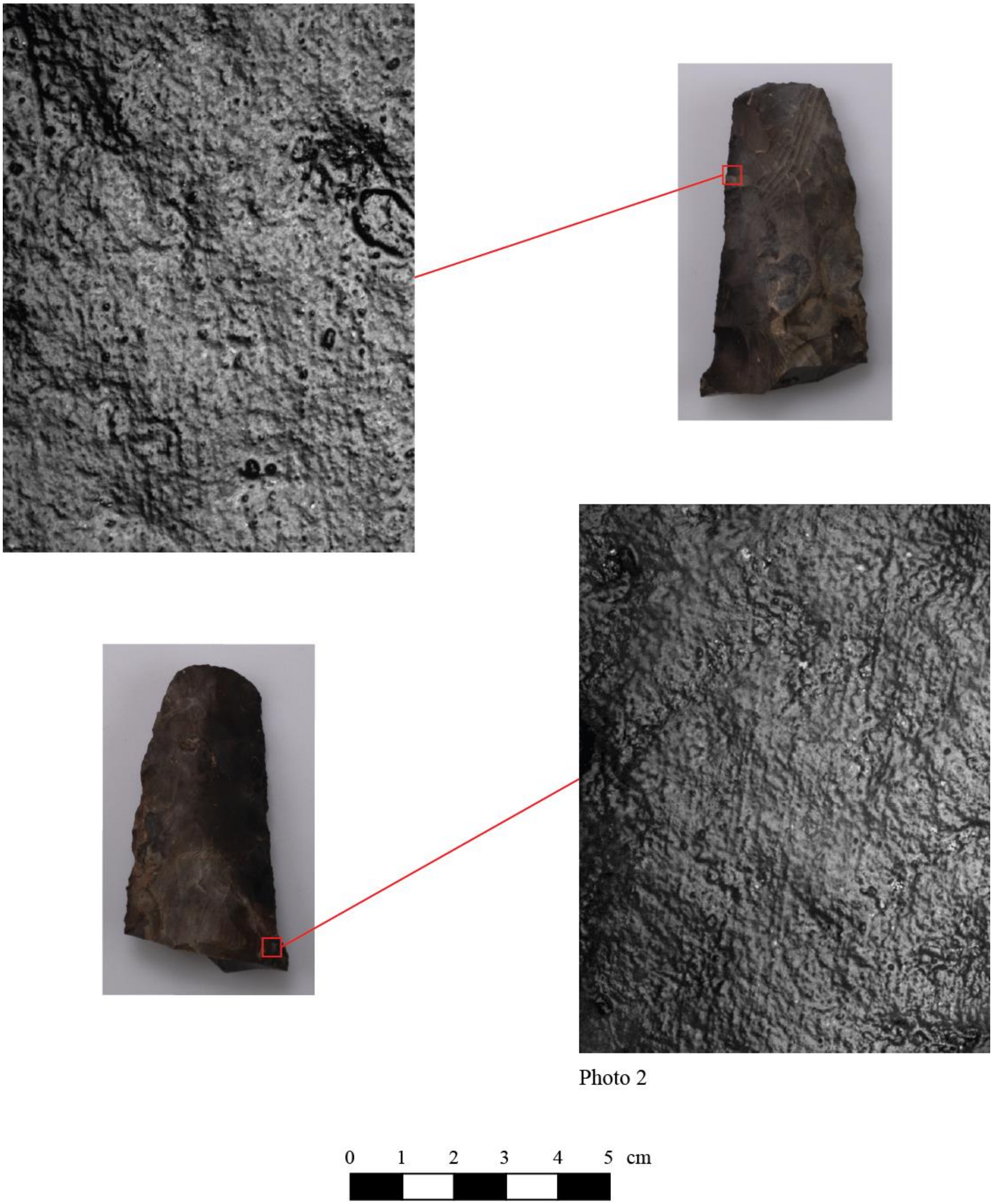

Figure 12. Locations of wear at 500X magnification on tool H7-2 from the Coffey site.

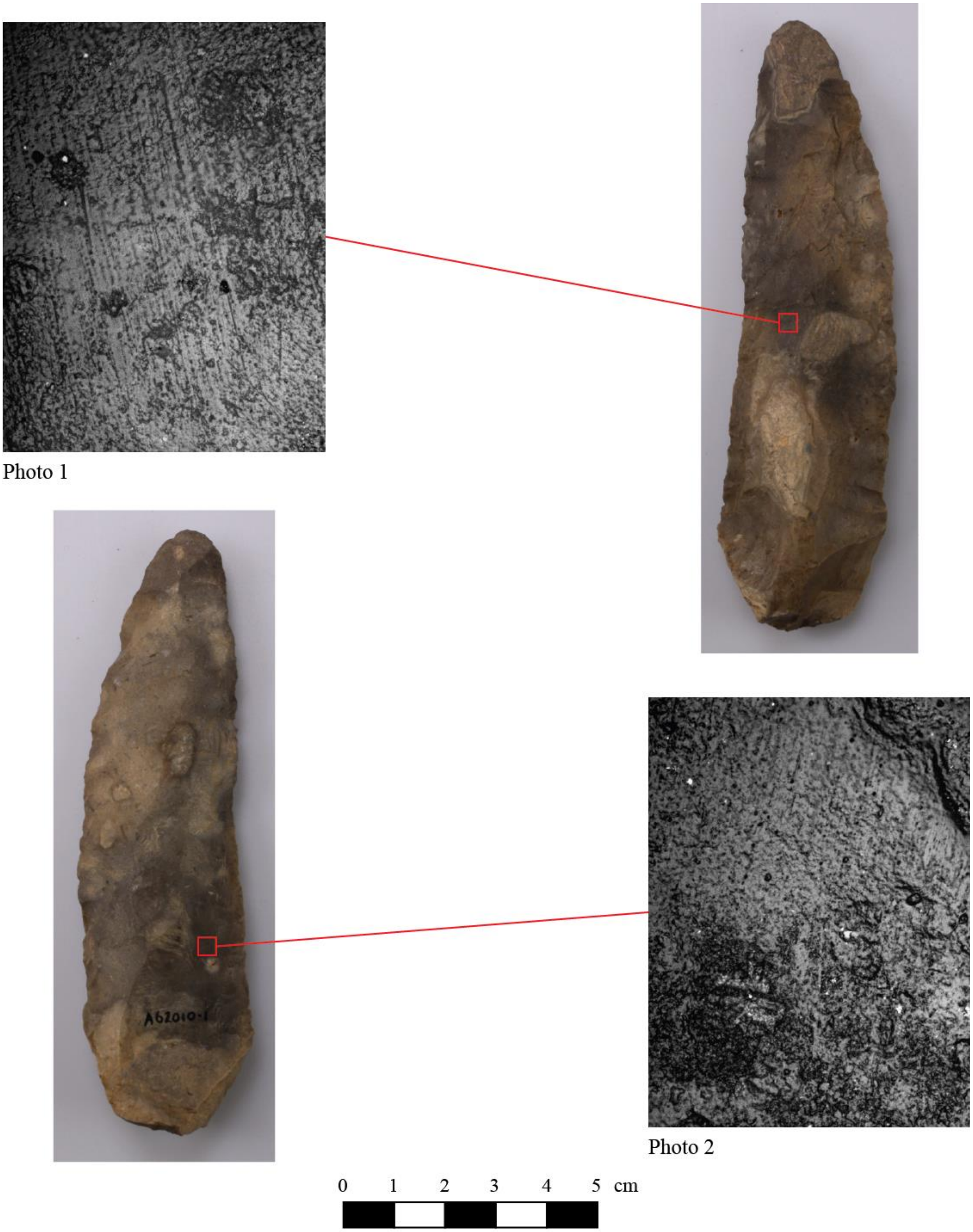

Figure 13. Locations of wear at 500X magnification on tool H8-1 from the Coffey site.

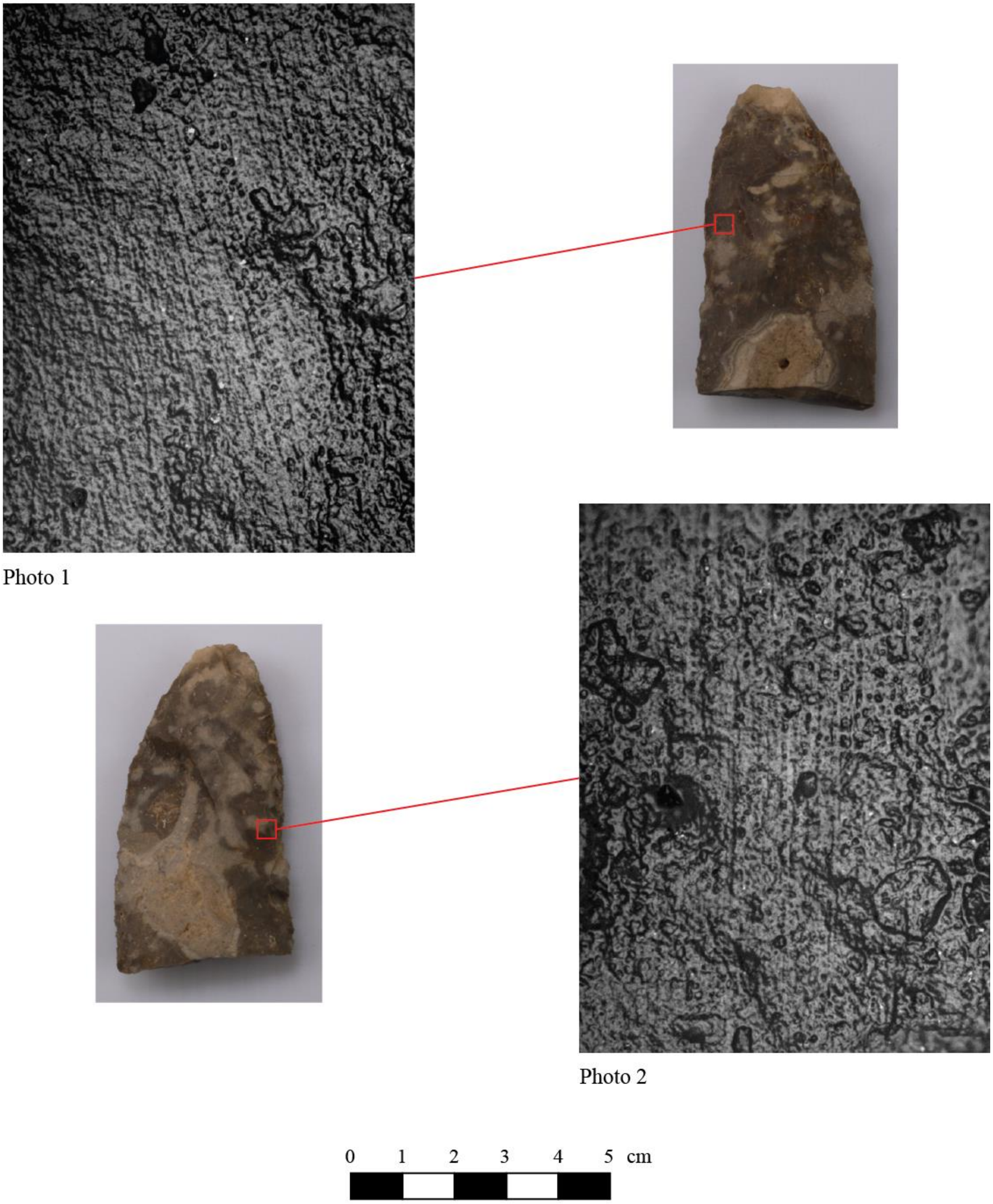

Figure 14. Locations of wear at 500X magnification on tool H8-2 from the Coffey site.

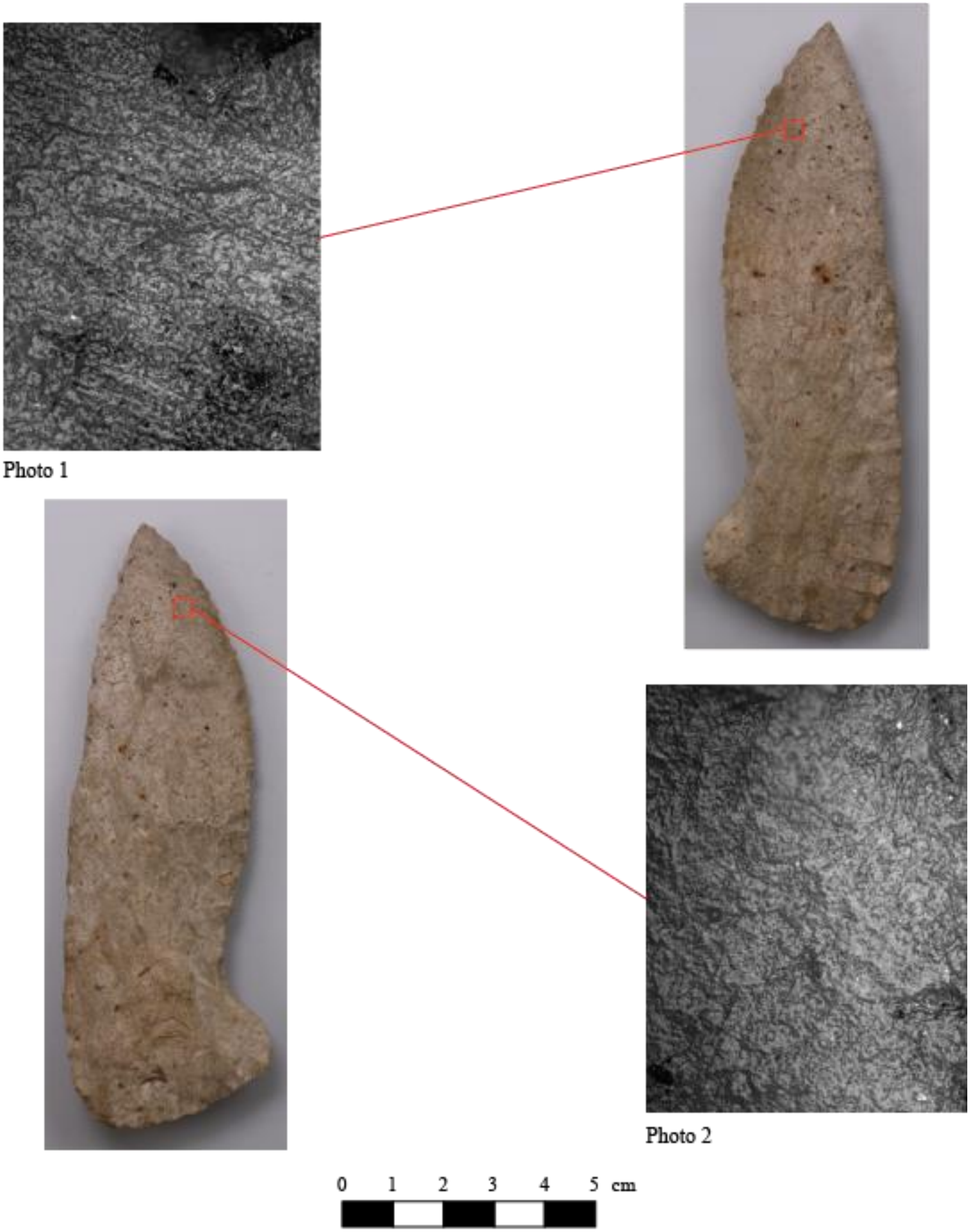

Figure 17. Locations of wear at 500X magnification on experimental tool edge E1.

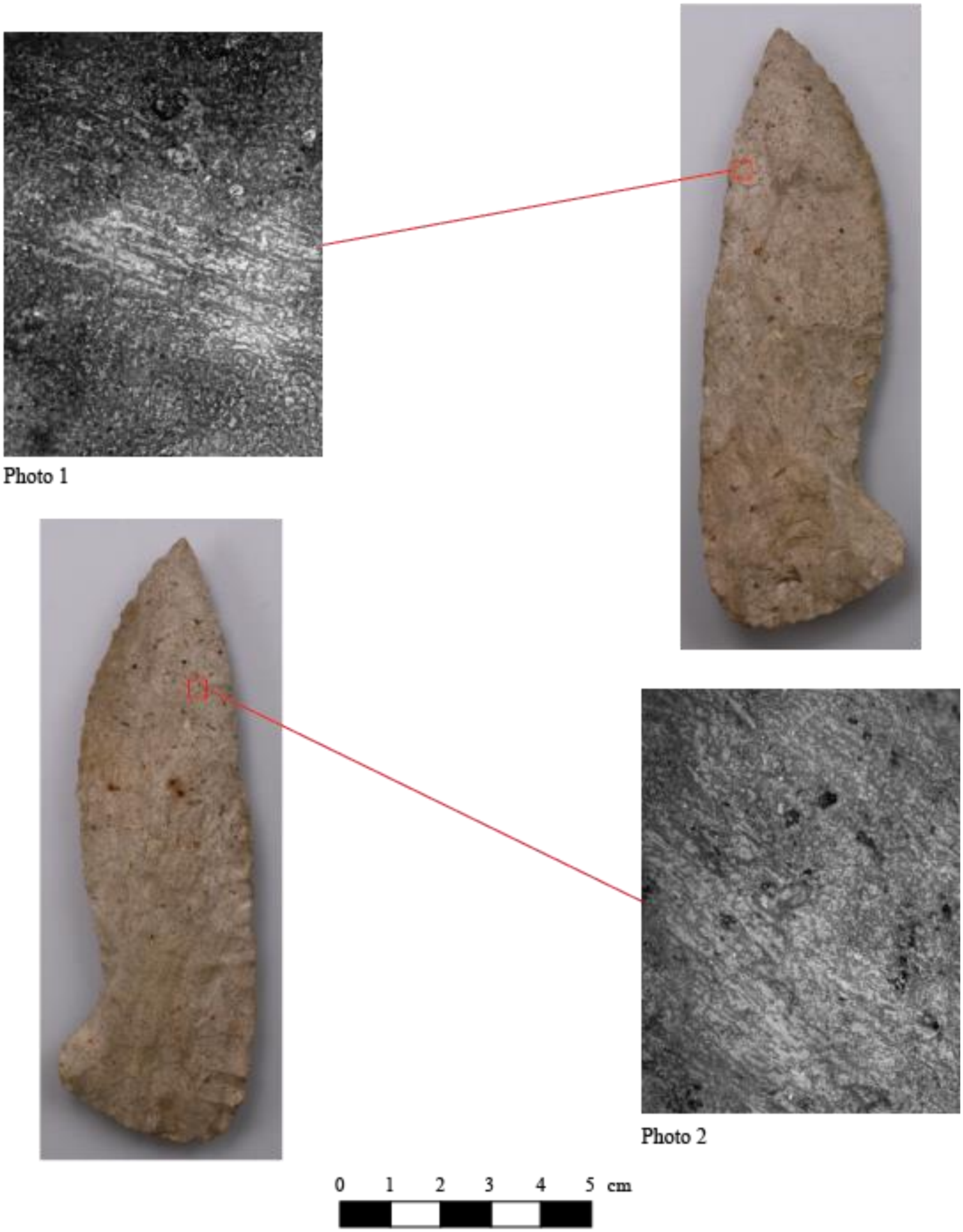

Figure 16. Locations of wear at 500X magnification on experimental tool edge E2.

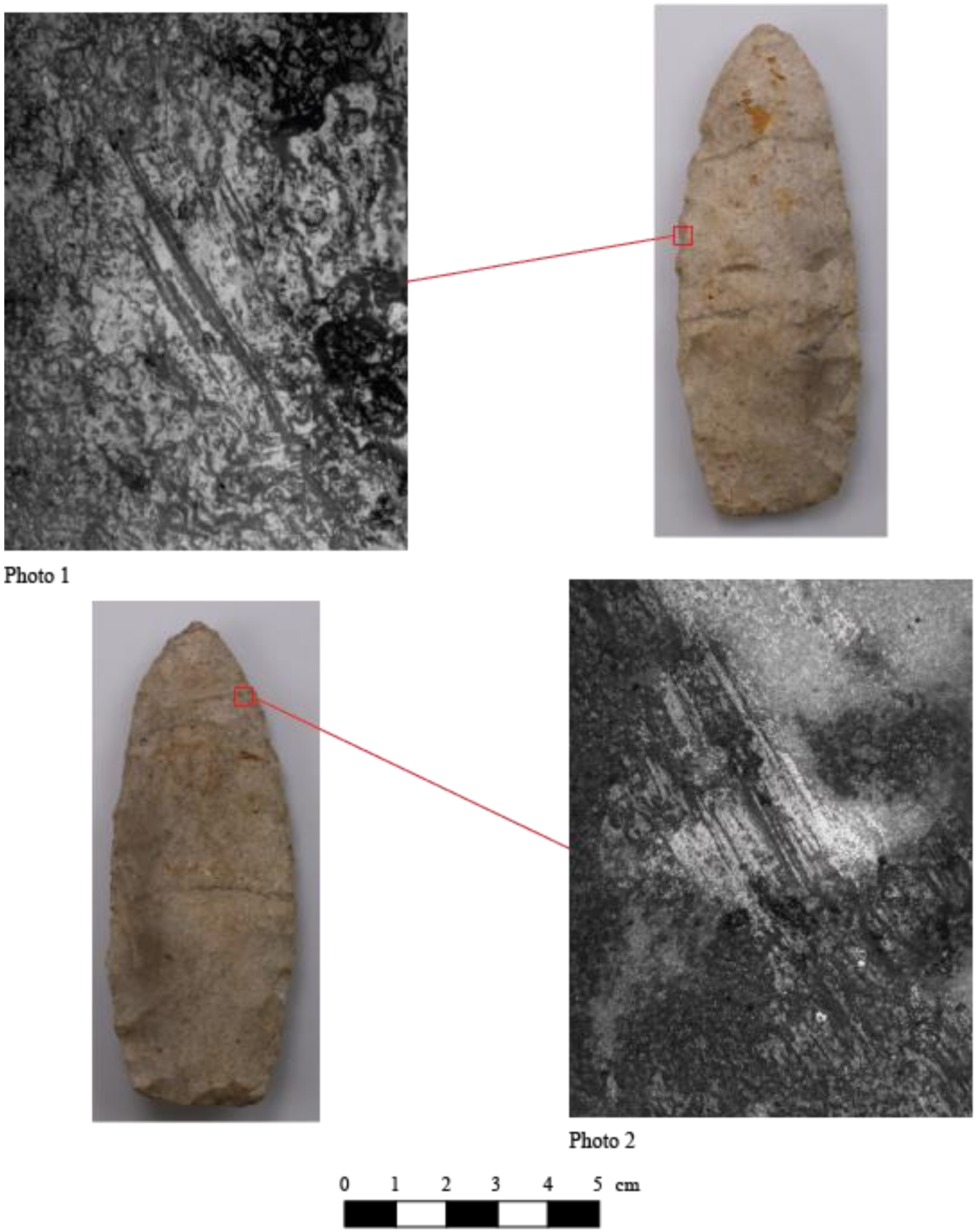

Figure 17. Locations of wear at 500X magnification on experimental tool edge E3.

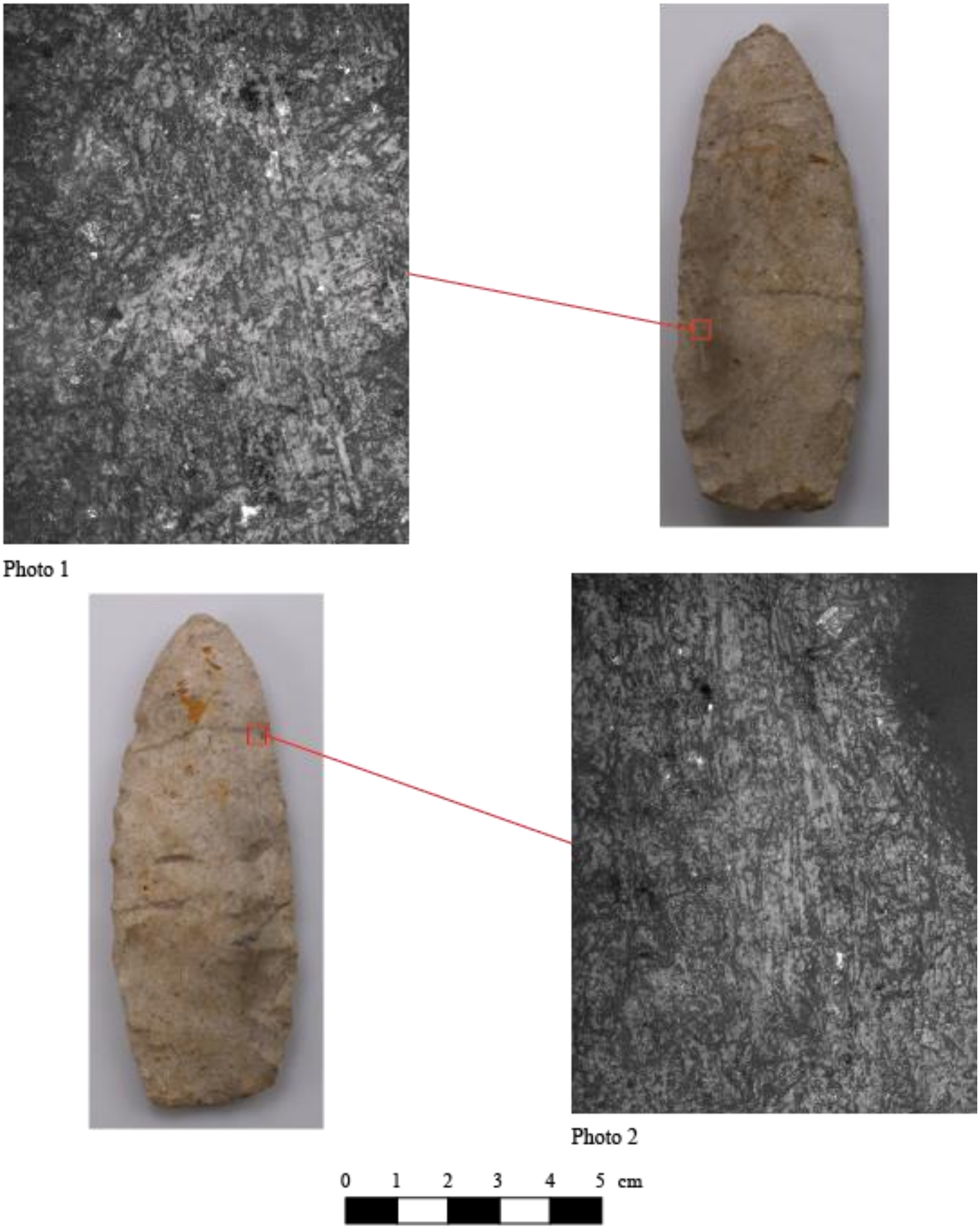

Figure 18. Locations of wear at 500X magnification on experimental tool edge E4.

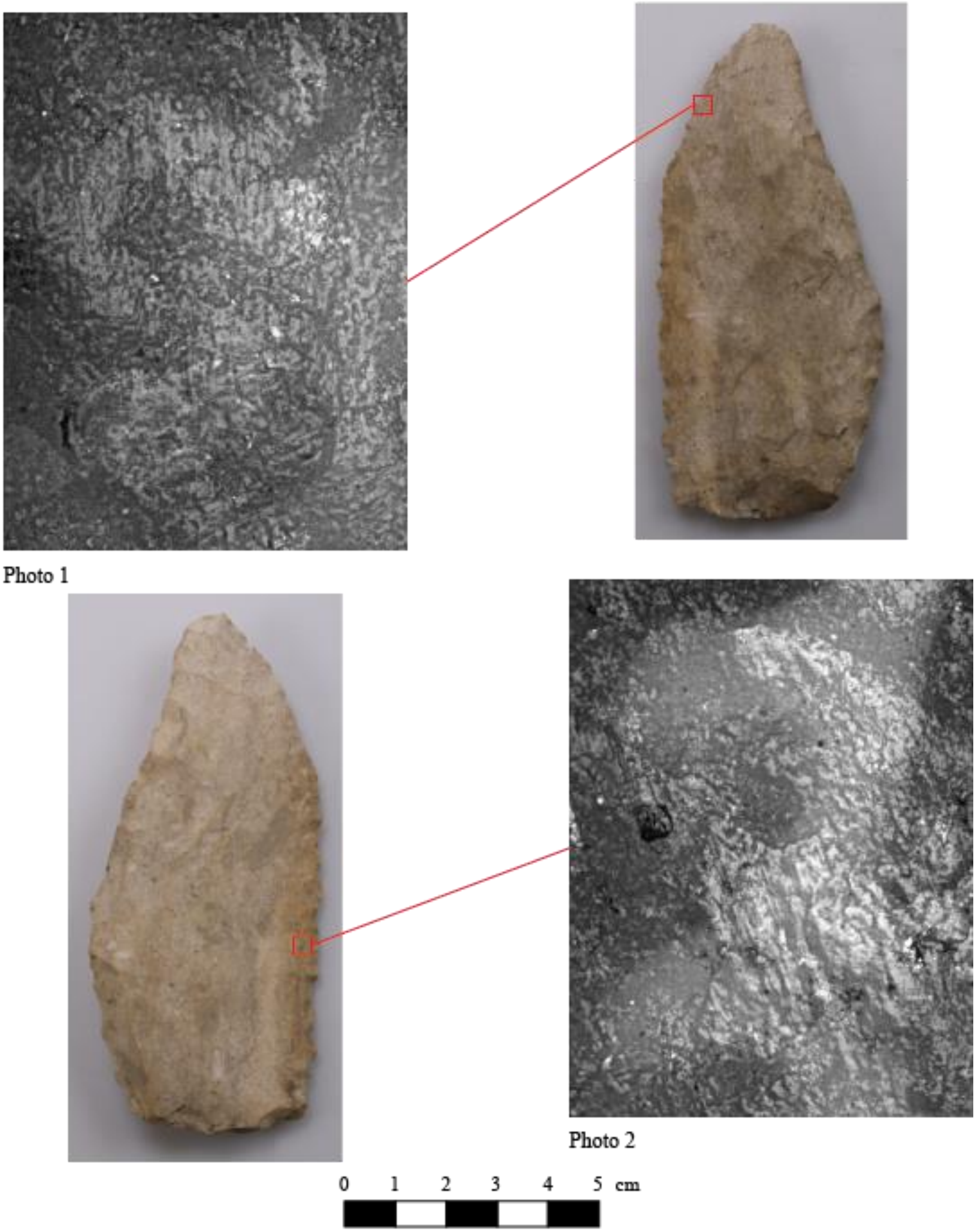

Figure 19. Locations of wear at 500X magnification on experimental tool edge E5.

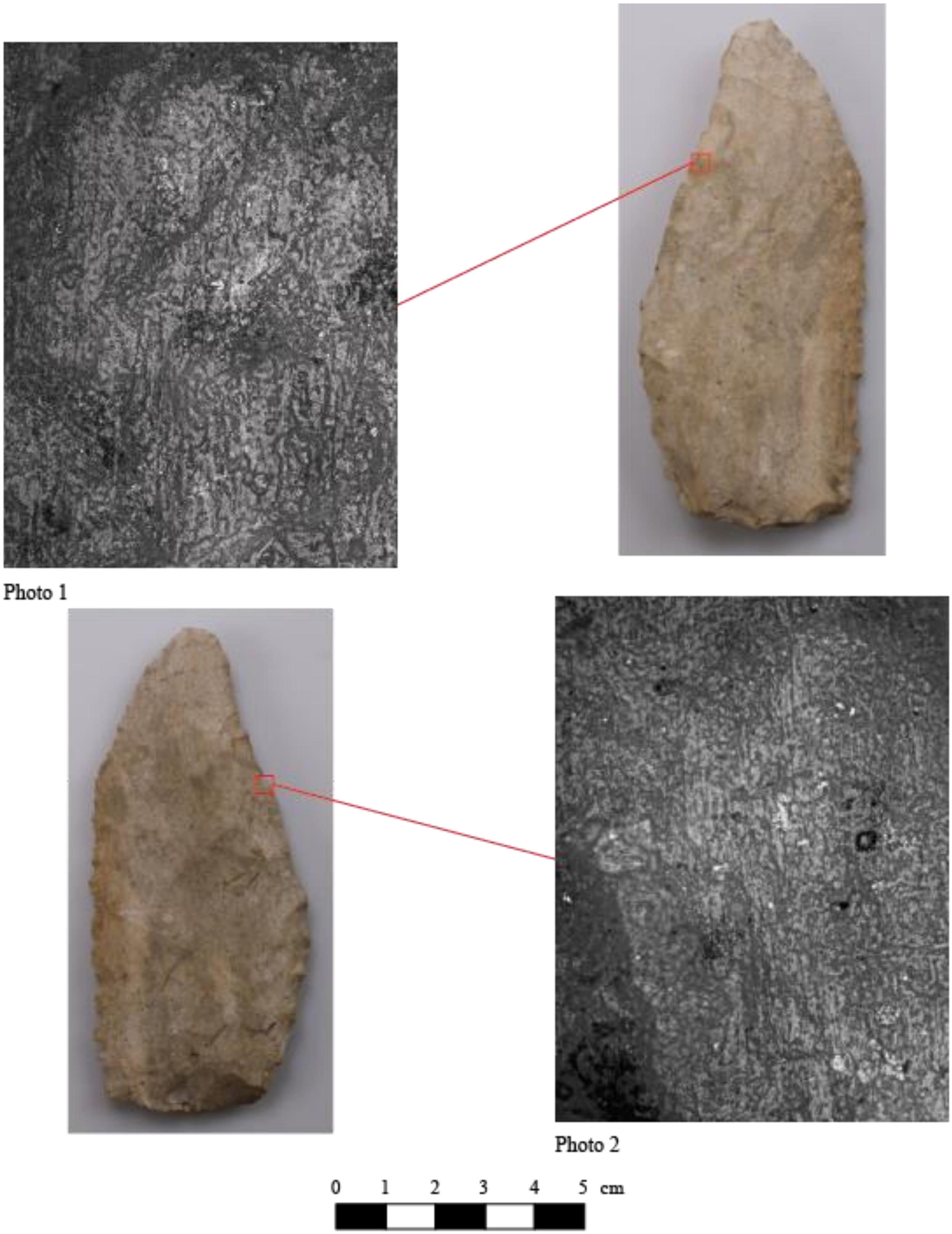

Figure 20. Locations of wear at 500X magnification on experimental tool edge E6.

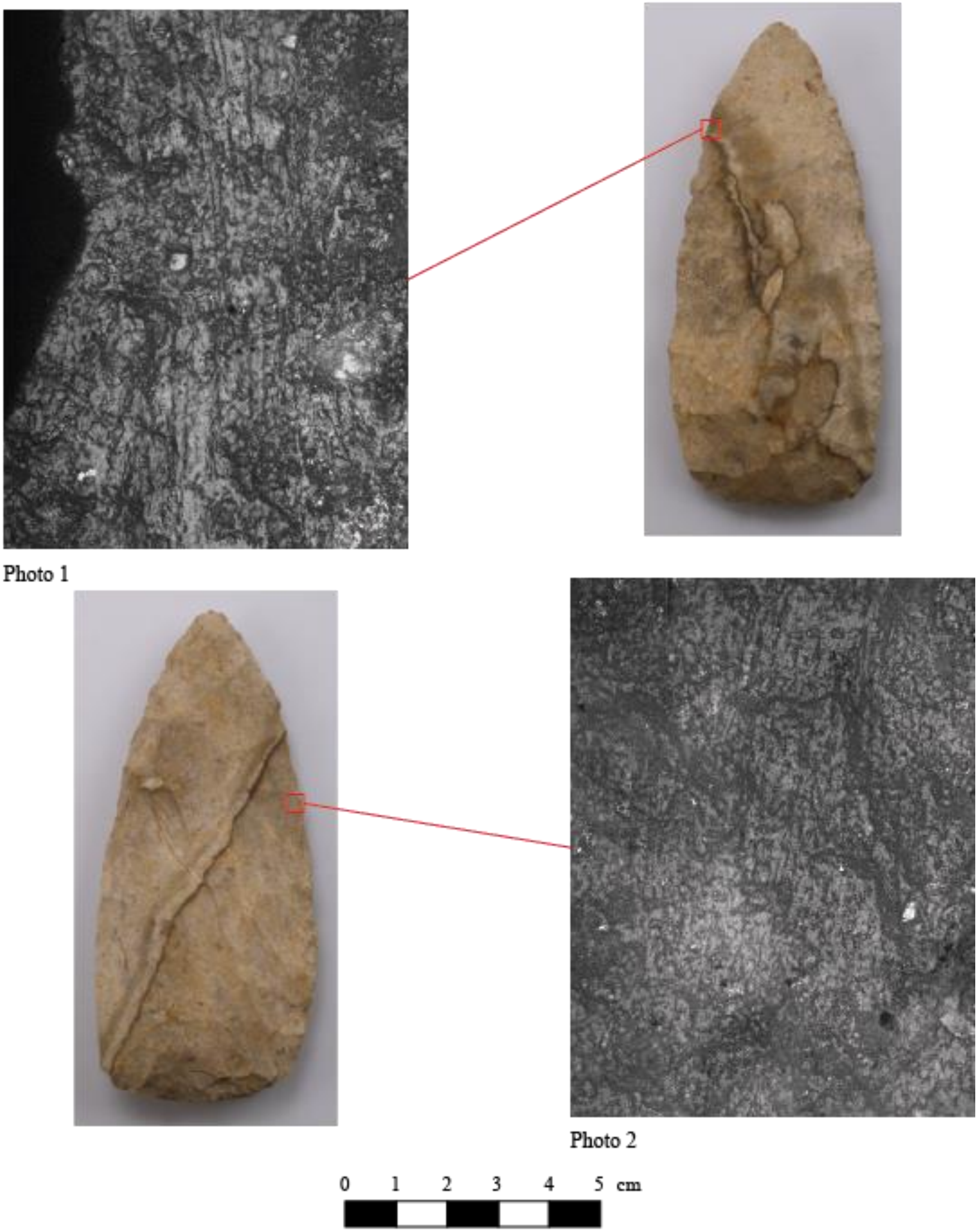

Figure 21. Locations of wear at 500X magnification on experimental tool edge E7.

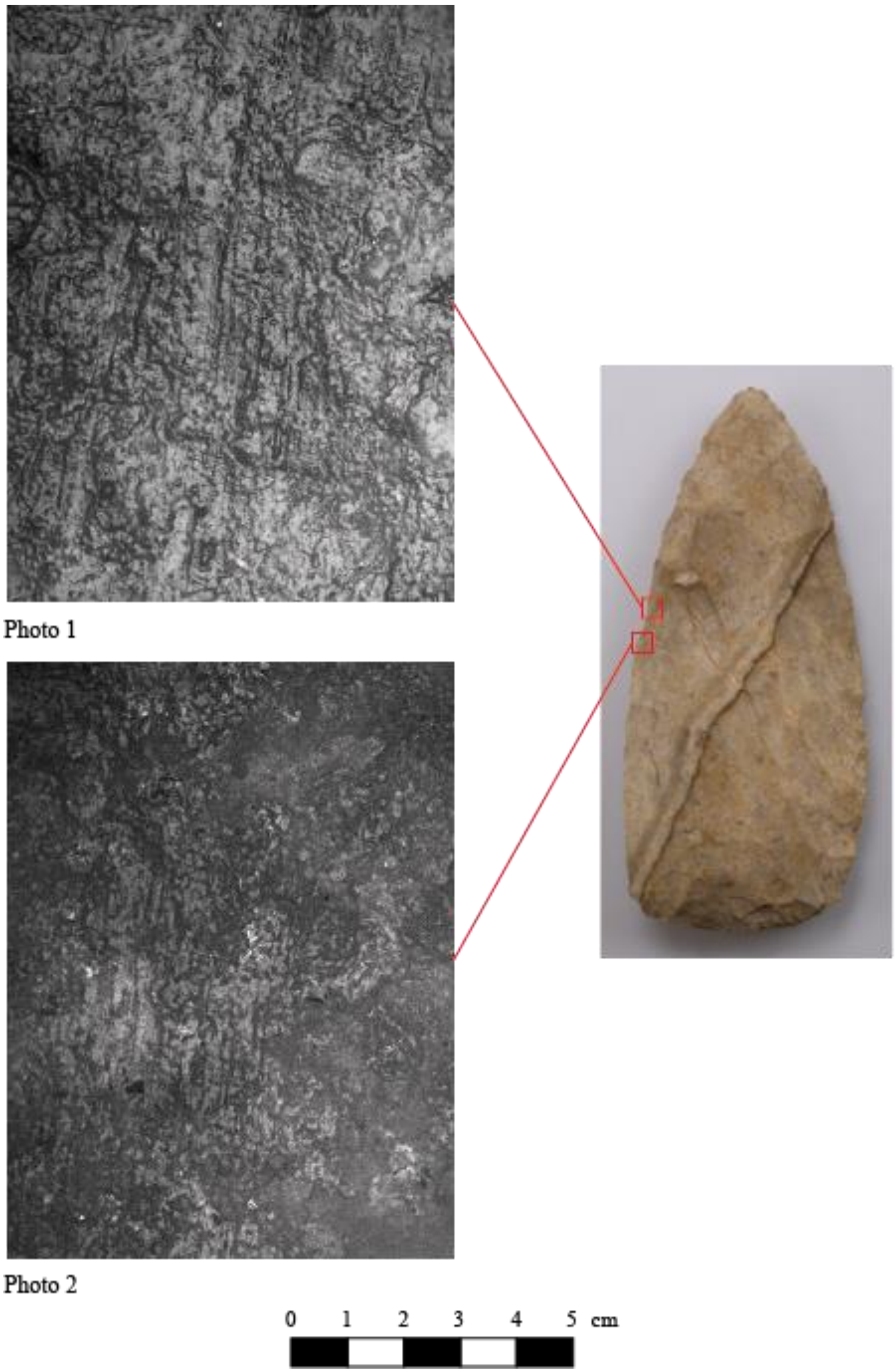

Figure 22. Locations of wear at 500X magnification on experimental tool edge E8.

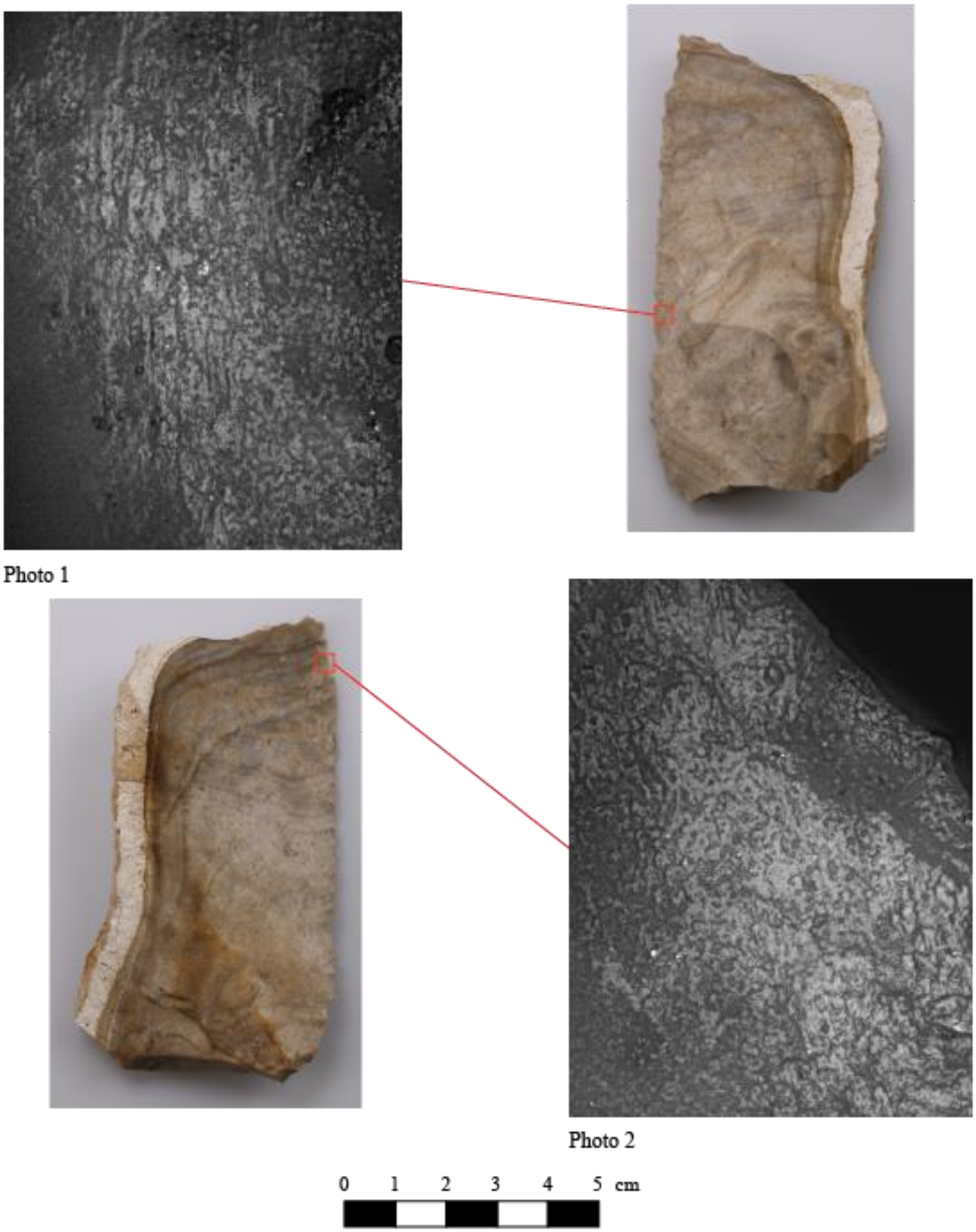

Figure 23. Locations of wear at 500X magnification on experimental tool edge E9.

IX. WORKS CITED

Adair, Mary J.

2006 Paleoethnobotanical Research in Kansas. In *Kansas Archaeology*, edited by R. J. Hoard and W. E. Banks, pp. 248-263. University of Kansas Press, Lawrence.

Anderson, P. C., J. M. Georges, R. Vargiolu and H. Zahouani

2006 Insights from a Tribological Analysis of the Tribulum. *Journal of Archaeological Science* 33(11):1559-1568.

Anderson, Patricia C.

1980 A Testimony of Prehistoric Tasks: Diagnostic Residues on Stone Tool Working Edges. *World Archaeology* 12(2):181-194.

Antevs, Ernst

1948 The Great Basin, with Emphasis on Glacial and Postglacial Times: Climatic Changes and Pre-white Man. III38:168-191.

Banks, William E. and Peter E. Wigand

2005 Reassessment of Radiocarbon Age Determinations for the Munkers Creek Phase. *Plains Anthropologist* 50(194):173-183.

Bettison, Cynthia Ann

1985 An Experimental Approach to Sickle Sheen Deposition and Archaeological Interpretation. *Lithic Technology* 14(1):26-32.

Binford, Lewis R.

1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1):4-20.

Blackmar, Jeannette M. and Jack L. Hofman

2006 The Paleoarchaic of Kansas. In *Kansas Archaeology*, edited by R. J. Hoard and W. E. Banks, pp. 46-75. University of Kansas Press, Lawrence.

Christensen, M., T. Calligaro, S. Consigny, J. C. Dran, J. Salomon and Ph. Walter

1998 Insight into the Usewear Mechanism of Archaeological Flints by Implantation of a Marker Ion and PIXE Analysis of Experimental Tools. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 136–138(0):869-874.

Clemente, Ignacio and Juan F. Gibaja

1998 Working Processes on Cereals: An Approach Through Microwear Analysis. *Journal of Archaeological Science* 25(5):457-464.

Del Bene, Terry A.
1979 Once Upon a Striation: Current Models of Striation and Polish Formation. In *Lithic Use-Wear Analysis*, edited by B. Hayden, pp. 167-177. Academic Press, New York.

Densmore, Frances
1928 Uses of Plants by the Chippewa Indians. *Bureau of American Ethnology Bulletin* 44:275-397.

Dorsey, James Owen
1896 Omaha Dwelling, Furniture, And Implements. *Thirteenth Annual Report Of The Bureau Of Ethnology, 1891-92*:263-288.

Fletcher, Alice C. and Francis La Flesche
1911 Omaha Tribe. In *Twenty-Seventh Annual Report Of The Bureau Of American Ethnology, 1905-06*, pp. 17-672 , 665 plates. Government Printing Office, Washington.

Gilmore, Melvin Randolph
1919 *Uses of Plants by the Indians of the Missouri River Region*. US Government Printing Office.

Grinnell, George Bird
1889 *Pawnee Hero Stories And Folk-Tales, With Notes On The Origin, Customs And Character Of The Pawnee People*. Forest and Stream Publishing Company, New York.

Grosser, Roger
1973 A Tentative Cultural Sequence for the Synder Site, Kansas. *Plains Anthropologist* 18(61):228-238.

Hyde, George E.
1974 Pawnee Indians. In *Civilization Of The American Indian Series*, pp. xii, 372. University of Oklahoma Press, Norman.

Jordan, Julia A.
2008 *Plains Apache Ethnobotany*. University of Oklahoma Press, Norman.

Kamińska-Szymczak, Jolanta
2002 Cutting Graminae Tools and "Sickle Gloss" Formation. *Lithic Technology* 27(2):111-151.

Kamminga, Johan
1979 The Nature of Use-Polish and Abrasive Smoothing on Stone Tools. In *Lithic Use-Wear Analysis*, edited by B. Hayden, pp. 143-158. Academic Press, New York.

Kay, Marvin
1998 The Central and Southern Plains Archaic. In *Archaeology on the Great Plains*, edited by W. R. Wood, pp. 173-200. University Press of Kansas, Lawrence.

Keeley, Lawrence H.
1980 *Experimental Determination of Stone Tool Uses: A Microwear Analysis*. University of Chicago Press, Chicago.

Küchler, August William
1974 A New Vegetation Map of Kansas. *Ecology*:586-604.

McBrinn, Maxine E.
2010 Everything Old Is New Again: Recent Approaches to Research on the Archaic Period in the Western United States. *Journal of Archaeological Research* 18(3):289-329.

McLean, Janice Ann
2010 A Reassessment of the Significance of the Coffey Site (14PO1), Tuttle Creek Lake, Pottawatomie County, Kansas, Anthropology, University of Kansas.

Meltzer, David J.
1999 Human Responses to Middle Holocene (Altithermal) Climates on the North American Great Plains. *Quaternary Research* 52(3):404-416.

Meltzer, David J. and Michael B. Collins
1987 Prehistoric Water Wells on the Southern High Plains: Clues to Altithermal Climate. *Journal of Field Archaeology* 14(1):9-28.

Miller, G. Logan
2014 Lithic Microwear Analysis as a Means to Infer Production of Perishable Technology: A Case from the Great Lakes. *Journal of Archaeological Science* 49:292-301.

Nabokov, Peter and Robert Easton
1989 *Native American Architecture*. Oxford University Press.

Powell, Terry J.
1980 An Archaeological Study of Burned Structures at the Orendorf Site, Fulton County, Illinois, Anthropology, Southern Illinois University, Carbondale.

Reynolds, John D.
1984 *The Cow-Killer Site, Melvern Lake, Kansas*. Kansas State Historical Society, Topeka.

Ritzenthaler, Robert Eugene and Frederick A. Peterson
1956 *The Mexican Kickapoo Indians* 2. Milwaukee Public Museum.

Schmits, Larry J.
1978 The Coffey Site: Environment and Cultural Adaptation at a Prairie Plains Archaic Site. *Midcontinental Journal of Archaeology* 3(1):69-185.

1987 The Williamson Site and the Late Archaic El Dorado Phase in Eastern Kansas. *Plains Anthropologist* 32(116):153-174.

Semenov, Sergei A.
1964 *Prehistoric Technology: An Experimental Study of the Oldest Tools and Artifacts from Traces of Manufacture and Wear*. Cory Adams and Mackay, London.

Simon, Mary L.
2002 Red Cedar, White Oak, and Bluestem Grass: The Colors of Mississippian Construction. *Midcontinental Journal of Archaeology* 27(2):273-308.

Smith, Craig S.
2003 Hunter–Gatherer Mobility, Storage, and Houses in a Marginal Environment: An Example from the Mid-Holocene of Wyoming. *Journal of Anthropological Archaeology* 22(2):162-189.

Thies, Randall M. and Thomas A. Witty Jr.
1992 The Archaic of the Central Plains. *Revista de Arqueología Americana* (5):137-165.

Unger-Hamilton, Romana
1984 The formation of use-wear polish on flint: Beyond the “deposit versus abrasion” controversy. *Journal of Archaeological Science* 11(1):91-98.

1985 Microscopic Striations on Flint Sickle-Blades as an Indication of Plant Cultivation: Preliminary Results. *World Archaeology* 17(1):121-126.

Unruh, David T.
2009 Zooarchaeology at the Coffey Site (14PO1): Mid-Holocene Economy on the Prairie Plains, Anthropology, University of Kansas, Lawrence.

Vaughan, Patrick C.
1985 *Use-Wear Analysis of Flaked Stone Tools*. University of Arizona Press, Tucson.

Wedel, Waldo R.
1986 *Central Plains Prehistory : Holocene Environments and Culture Change in the Republican River Basin*. University of Nebraska Press, Lincoln.

Weltfish, Gene
1965 *Lost Universe: With A Closing Chapter On 'The Universe Regained'*. Basic Books, New York.

Widga, Christopher C.
2007 Bison, Bogs, and Big Bluestem: The Subsistence Ecology of Middle Holocene Hunter-Gatherers in the Eastern Great Plains. Ph.D., The University of Kansas, Ann Arbor.

Witthoft, John
1967 Glazed Polish on Flint Tools. *American Antiquity* 32(3):383-388.

Witty, Thomas A. Jr.
1982 The Slough Creek, Two Dog, and William Young Sites, Council Grove Lake, Kansas. *Kansas State Historical Society, Topeka, Anthropological Series* (10).